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State of California
The Resources Agency
Department of Fish and Game

A SURVEY OF THE COASTAL WETLAND VEGETATION OF NORTH SAN DIEGO COUNTY 1/

by

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ABSTRACT

California's coastal wetlands, particularly those in Southern California, are rapidly diminishing because of rapidly changing land uses. Three important wetland areas occurring on the Camp Pendleton Marine Corps Base, San Diego County, were studied by Peta Mudie.

Important plant communities were identified and cover mapped at the mouths of the Santa Margarita, Las Flores, and San Mateo rivers. A check-list of wetland plants was provided and semi-permanent transects for future evaluation were established. In addition, recommendations are made towards improvement of the coastal wetlands for fish and wildlife.

1/ Wildlife Management Administrative Report No. 70-4 (June, 1970). Supported by Federal Aid in Wildlife Restoration Project W54R-1 "Special Wildlife Investigation".

TABLE OF CONTENTS

INTRODUCTION

The following report records the results of a study of the wetland vegetation of the Santa Margarita, Las Flores and San Mateo estuaries, located on the north coast of San Diego County, California. As indicated in Contract No. W54R1-6 of the California Department of Fish and Game, the study included the following:

1. Cover mapping of the vegetation types, determination of their acreages, and assessment of the relative abundance of the major species.

2. Check-lists of the wetland plants and determination of their ecological groupings.

3. Establishing of semi-permanent transects for future evaluation.

This study of the coastal wetland vegetation is part of a wildlife survey and proposed enhancement plan for the estuarine habitats at the Camp Pendleton Marine Corps Base. This project is being carried out by the California State Department of Fish and Game in an effort to counteract the progressive destruction of the coastal wetlands in San Diego County. This habitat is essential for the maintenance of thousands of migratory waterfowl, shorebirds, and other water-associated birds dependent on California's coastal wetlands. Estuarine environment is also essential for successful reproduction of certain types of shellfish and inshore marine fish.

At the turn of the century, coastal marshlands covered approximately 32,000 acres in San Diego County (Purer 1942). With the steady increase in population in the narrow coastal belt however, the activities of man made drastic inroads into these wetlands. More than one-half of the original acreage of marshland was located around Mission Bay, San Diego Bay and at the mouth of the Tia Juana River. It is believed that by 1975 only about 276 acres of marshland will remain in these areas.

Elsewhere in San Diego County, coastal wetlands are confined to relatively small areas (300 acres or less) at the mouths of the larger rivers. At present, plans are being formed for converting three of these areas (Del Mar, San Elijo and Batiquitos Lagoons) into marinas. Only the marshlands at Los Penasquitos and Buena Vista are presently being held in a natural state by protective agencies. Thus it is imperative that protection be extended to additional areas if the current levels of wildlife populations are to be maintained.

The enhancement plan proposed by the California Department of Fish and Game aims at restoring the tidal estuarine habitat at the mouth of the Santa Margarita River and forming a fresh-water pond north of the river and in the Las Flores areas. Plans have not yet been formulated for the improvement of San Mateo region but there are several localities within this area that would be suitable for the construction of fresh-water ponds.

Few attempts have previously been made to improve the wildlife habitat in the Southern California coastal region, making it difficult to predict accurately the success of planned improvements. However, restoration of tidal action in the Los Penasquitos and Agua Hedionda Lagoons resulted in dramatic increases in the wildlife populations (Bradshaw 1968, Miller 1966). Improvements made to the freshwater pond north of the Santa Margarita River by the U. S. Marine Corps, likewise, has resulted in considerable increase in wildlife. (Mr. Edward Green, pers. comm.). On basis of these previous achievements, it would appear that proposed enhancement plans hold a high probability of being successful. It should be noted, however, that much of the drainage entering the ponds in the study areas comprises run-off from cultivated fields. It would thus be highly advisable to examine pesticide residue levels in these areas prior to encouraging an increased use by wildlife.

REVIEW OF LITERATURE

Coastal saltmarsh vegetation of California has been fairly well studied over the past thirty years. In addition, an extensive volume of literature exists for saltmarsh studies in other regions of North America (see Chapman 1960, Hinde 1954). Because of these studies, it is possible to analyse the variation patterns within the saltmarsh at a fairly sophisticated level of interpretation.

The earliest comprehensive study of Californian saltmarsh vegetation was that of Purer (1942) who surveyed most of the coastal marshes between the Tia Juana River and the Santa Margarita River. Purer related distribution of the vegetation types to tide levels and soil salinities and attempted to interpret distribution of nine major plant species in terms of their anatomical features. Although this work is of a classical pioneering nature, it suffers from generalities due to insufficient sampling and lumping of data from very diverse estuarine environments.

Detailed studies have been made of the vegetation zonation in relatively undisturbed saltmarshes near Palo Alto (Hinde 1954) and at Newport Bay (Stevenson and Emery 1958, Vogel 1966). These authors concluded that the zonation was determined chiefly by the patterns of tidal submergence prevailing in these areas. The intensive quantitative work of Macdonald (1967, 1968) in a number of Pacific Coast saltmarshes, however, suggested a somewhat more complicated picture. In the marshes south of Point Conception, a succession of well-marked vertical zones of vegetation could be determined; whereas, in the northern marshes, the relative abundance of individual species appeared to change gradually and independently with elevation to produce a vegetational continuum.

The preliminary study of the species distribution in the saltmarsh at Los Penasquitos (Bradshaw 1968) also indicated that the zonation may be more complicated in a small lagoon subjected to tidal activity for restricted periods of time. This work is the only detailed study that has been made on the vegetation of a temporary Californian estuary such as exists at the mouth of the Santa Margarita River. Other brief but useful references to this particular environment are included in the study of the molluscan fauna of several small lagoons in San Diego County (Miller 1966) and in a study of the eutrophication of San Elijo Lagoon (Ganon and Nusbaum 1967).

In contrast to the relatively large amount of literature on the Californian saltmarsh vegetation, published literature on fresh and brack-water marsh vegetation of California is very sparse. Mason (1957) has adequately documented the taxonomy and regional distribution of Californian marsh flora but his work contains only general references to the ecology of the species. The most detailed work on biology of the aquatic vascular plants of North America (Sculthorpe 1967) does not include any references to the ecology of the Californian fresh-water marshes. It was thus necessary to refer to literature on marshes from various other regions of North America in order to interpret the vegetation patterns of the study areas. Only the most useful references are included here.

Penfound and Hathaway (1938) studied the marshland plant communities of south-eastern Louisiana and correlated the distribution of the species with water and soil water levels and salinities. This paper included studies of transition areas between salt and fresh-water marshland - an environment similar to that found at the Santa Margarita River study area.

Studies of Keith (1961) on waterfowl ecology of ponds in south-eastern Alberta, and Bolen (1964) on a spring-fed marsh in Utah provide quantitative data on distribution of plant species in inland marshes of variable salinity. Both these authors were able to correlate marked changes in vegetation composition with differences in the salinity of the soil water. Several of the dominant species present in these areas were the same as those of the areas studied in this report, thus allowing for limited extrapolation of this inland data to the coastal fresh-water marshes at Las Flores and San Mateo.

Several studies have been made on changes occurring in the vegetation of fresh and brack-water marshes due to the alteration of surface water levels (Brown and Cottam 1950; McDonald 1955; Harris and Marshall 1963). Data in these publications was useful in interpreting some of the anomalous variation patterns in the vegetation at Las Flores and San Mateo, areas which have been subjected to varying levels of soil and surface water and to disturbance by human activities in the recent past.

PHYSICAL ENVIRONMENT OF STUDY AREAS

Physiography

The Santa Margarita, Las Flores and San Mateo study areas are located in the coastal region of the Marine Corps Base at Camp Pendleton, in Northwestern San Diego County (Fig. 1 Appended). The topography and boundaries of each study area are shown in Appendices A, B and C.1/ All three areas occupy broad, flat-bottomed valleys adjacent to the mouths of rivers that are only periodically connected with the ocean. These valleys are flanked on

1/ U.S.N. Aerial Topographic Survey maps retained in project files.

the north and south sides by steep-sided coastal terraces and on the seaward side by dune barriers up to ten feet in height. The valleys are underlain and bordered by sedimentary rock of Tertiary origin (Ellis and Lee 1919). The floors of the valleys above this base rock comprise thick deposits of alluvial material derived from the sedimentary mesa formations of the coastal belt and granitic formations of the interior mountains. This alluvium was probably deposited in recent times during an advance of the sea which formed large bays in these areas (ibid.). With the progressive accumulation of silt and the increasing aridity of the climate, the formerly wide river mouths became restricted to relatively narrow channels dissecting the low alluvial plains.

Hydrology

The present hydrology of the Santa Margarita, Las Flores and San Mateo Rivers is summarized in Table 1 Appended. Surface water flows are typical of rivers in the low-rainfall Southern Californian region; they display a wide annual range in volume and large fluctuations in maximum discharge from year to year. The potential maximum discharges of the Santa Margarita and San Mateo Rivers (as indicated by flows at periods of dam failure) are considerably larger than the maximum flows normally encountered in years of heavy rainfall (eg. 1966) and may cause extensive damage in the lower parts of the river courses. It is interesting to note that the median of the yearly mean discharge of the San Mateo River is considerably smaller than that of the Las Flores River even though the Las Flores drainage basin is only one-quarter the area of the San Mateo River.

The flow of the Santa Margarita River has been partially regulated by Vail Lake since 1948. In addition, water is diverted for irrigation at various points along its course. The flow of the Las Flores River is not regulated but some pumping for irrigation occurs upstream. Minor flows of the San Mateo River are regulated by percolation basin but there is no upstream diversion of water (U. S. Dept. Interior Geological Survey 1967).

The mouths of all three rivers become cut off from the ocean for six or more months of each year. The present closure of the river mouths is a result of a combination of low fresh-water discharges during the summer months and deposition of sand at the river entrances by onshore waves and longshore currents. Technically, the impounded bodies of water cannot be classified as estuaries or lagoons since they do not maintain a permanent connection with the ocean. They conform in structure and formation with the "blind estuaries" of South Africa (Jennings and Bird 1967) and with the shore-line lakes or "ponds" of the New England coast (Reid 1961). However, since the terms "estuary" and "lagoon" have long been loosely applied to various types of coastal embayments (Gorsline 1967) and equivalent bodies of water in Australia are referred to as "estuarine lagoons" (Jennings and Bird loc. cit.), for the sake of convenience the term "lagoon" will be used in this report.

Large quantities of silt have been accumulating in these lagoons over the past two hundred years as a result of the erosion from settlement and cultivation of the upstream valleys (Ellis and Lee 1919). The natural drainage patterns of these rivers has also been considerably altered by the construction of a railroad and a succession of highways across the mouths. Both these factors have undoubtedly contributed to the failure of the rivers to maintain an open connection with the ocean in recent times. Closure of the lagoon mouths further increases the rate of silt deposition (Chapman 1960) while the accumulation of silt in turn reduces the flushing action of the tides in the lagoons during periods of connection with the ocean.

Study Areas

San Mateo

At present, almost all of the San Mateo study area lies above the level of tidal influence. No saltmarsh vegetation exists in this area. The wetlands support a dense cover of fresh or brackish-water marsh vegetation interspersed between thickets of willow. The upland border of this region south of the river, comprises a stable riparian woodland community. The low-lying marshy areas are subjected to inundation during winter flooding of the river. In addition, the marsh in the south-western half of this area appears to be fed by ground water seepage from a stream to the west of the Freeway.

Las Flores

Similarly, at Las Flores, most of the area lies above the level of tidal influence. However, small pockets of saltmarsh vegetation occur in the lowest part of the drainage area to the north of the river, suggesting occasional excursions of tidal water across low places in the dune barrier. Small areas of saltmarsh vegetation also exist on the margins of the lagoon at the mouth of the river. However, most of the wetland vegetation comprises fresh or brack-water marsh. This occupies a narrow belt (200 feet wide or less) bordering the lagoon and an area of approximately 18 acres in the seepage area to the north of the river. This seepage is currently fed by a small spring that enters from a drainge ditch under the Freeway and follows the course of a shallow depression that possibly marks the position of an ancient channel of the river.

Santa Margarita

The Santa Margarita study area presents a very different physiographical picture. Most of this region lies below five feet above mean sea level and comprises extensive areas of saltmarsh bordered on the inland edge by barren salt flats. Three small channels traverse the saltmarsh, providing drainage during periods of tidal conditions. Two large brack-water ponds south of the river mark the courses of earlier channels. Subfossil remains of oysters, cockles, bubble-shells and jack-knife clams are exposed at the surface in places, indicating the existence of an extensive tidal lagoon in relatively recent times. Studies of Indian middens at Los Batisquitos Lagoon, south of Oceanside, showed that this area comprised a well-flushed open lagoon as recently as 825 +/- 200 years b.p. (Miller 1966). It is likely that similar conditions existed in the Santa Margarita area at that time. The lagoon has also remained open to tidal action for several consecutive years during the past 70 years (Ellis and Lee 1919; Purer 1942); it also remained open for the duration of the study period.

To the north of the lagoon lies a small slightly brackish pond, locally referred to as Sweetwater. This pond appears to be fed mainly by runoff and seepage from irrigated fields on the mesa to the north. This permanent source of fresh water also maintains the narrow belt of fresh-water marsh and patches of willow swamp that fringe the northern upland edge of this area.

The soil in all three study areas is predominantly a fine, gray-brown silty or sandy clay. At the inland edge of the beach dunes, the soil generally contains a higher percentage of sand, with the transition to the coarse sand of the dunes being very abrupt in some places. In areas covered by standing water, the surface soil is a reduced, mucky black clay containing small amounts of plant remains. Below this surface clay, the soil tends to grade into a lighter-colored silty sand.

METHODS OF VEGETATION STUDY

Field work commenced in mid-April 1969 and was carried out over a period of two and a half months. Fifteen field trips were made to the study areas at approximately bi-weekly intervals. Work in the Las Flores and San Mateo areas was slowed by the inaccessibility of these regions since the entry roads were washed out during the previous winter floods. In addition, the density of the cat-tail, bulrush and willow communities in these areas made extensive sampling a slow process.

After a preliminary survey of the vegetation composition of each area, the major plant communities were delimited on the basis of the dominant species present and the general aspect (height, spacing etc.) of the vegetation. Distribution of the major wetland communities was then mapped on aerial topography base maps (scale 1" = 400') by "eye-balling" in the boundaries from adjacent elevated points. The boundaries were later corrected from USN aerial photographs taken in March 1969 but insufficient time was available for accurate surveying. The community boundaries are only approximate as are the acreages which were determined from the vegetation maps by means of a planimeter.

Checklists of the wetland plants were compiled from field observations and limited plant collections. Species were identified using Mason (1957) or Munz (1959) and Higgins (1949); nomenclature follows that of Munz (op. cit.). Doubtful identifications were checked at the herbarium in the San Diego Museum of Natural History; in some cases the plants were pressed to await more accurate determination. Owing to the brief duration of the study period, certain species in which floral characters are critical for determination were not observed in flower and thus could not be accurately identified. It is hoped that these identifications may be determined later this year.

The relative abundance and ecological grouping of the wetland species was determined from casual observations over a wide area and from detailed sampling along transects or in selected areas. Where detailed sampling was carried out, relative abundance was estimated using the following abundance classes (Smith 1966):

	Stalks/ m^2 quadrat
Rare (r)	1 - 4
Occasional (o)	5 - 14
Frequent (f)	15 - 29
Abundant (a)	30 - 99
Very abundant (va)	100 +

When estimating the abundance of species with prostrate stems that root at the nodes (eg. Salicornia, Distichlis, Anemopsis) the erect branches of a single stem were counted as single stalks. In the abundance estimates of the cat-tails (Typha) and bulrushes (Scirpus), all erect shoots were counted regardless of whether dead or alive since the erect dead shoots usually simply represent the previous year's stalks on a single living shoot system. However, where the dead stalks were prostrate and flattened, they were treated as litter.

Two semi-permanent belt transects were set up in each study area to assess the present vegetation composition and to evaluate future changes that may occur. The transect sites were selected to cover the maximum range of vegetation types. It is also planned to set up an additional transect across the salt flats at Santa Margarita. The transects were permanently marked by 2 ft. lengths of aluminum tubing at approximately 50 ft. intervals and were roughly located on the maps by means of compass bearings. It is intended to survey in these transects at a later date.

Sampling along the transects was carried out by means of square meter quadrats placed at 20 ft. intervals along a marked line stretched between 6 ft. wooden dowels that were inserted into the aluminum stakes. In areas of rapid vegetation changes over a short distance, samples were made at 10 ft. intervals.

At each sample station, relative abundance was recorded (as already outlined) and percent coverage estimated for each species. The coverage represents gross canopy coverage i.e. the percentage of ground included in a vertical projection of imaginary polygons drawn about the total natural spread of foliage of the individuals of a species (Daubenmire 1968).

The great diversity of vegetation at San Mateo made it necessary to sample several other localities in addition to the transect sites. The sampling methods employed are noted in Table 5 Appended, following the techniques outlined by Daubenmire (op. cit.). Relative abundance and percent cover in these samples were determined as outlined above.

In order to interpret the variation patterns of the vegetation in the study areas, it was necessary to conduct a preliminary study of certain soil parameters along the transects and at other critical sites. Soil samples were taken by means of a plexiglass corer ($1\frac{1}{2}$" i.d.) fitted with a rubber-topped plunger or a soil auger (3" i.d.). At most sites, only the top four to six inches of soil were sampled, this being the root zone of the majority of species present. The samples were stored in sealed plastic bags and kept in the refrigerator for up to five days.

The water content of the samples was determined by drying the soil at approximately 105° C and calculating the percent loss in weight. 50 gm samples of soil were then eluted with 250 ml distilled water to obtain 1:5 extractions of the soil water. The residues were dried and stored for future analysis of soil particle size. The 1:5 extractions were analyzed for pH, electrical conductivity and Cl^- concentration. Conductivity was measured at 25° C using an Industrial Instruments conductivity bridge. The Cl^- concentration was calculated for 50 or 10 ml aliquots by means of the standard Mohr ($AgNO_3$) titration method.

RESULTS OF FIELD STUDIES

Vegetation Types

Delimitation of Plant Communities

Wide differences in the nature of the water supply and in soil salinity between the study areas made it difficult to delimit plant communities that were comparable. Characterization of comparable communities was further complicated by the fact that all three areas have been subjected to varying degrees of human disturbance in the past and thus many of the communities include a variable weed flora. In general, however, twelve major vegetation types were recognized on the basis of the general aspect and floristic composition of the vegetation. Five of the vegetation groups are essentially upland communities although some of them may occasionally be subjected to flooding. The remaining seven vegetation types comprise the wetland communities that generally occupy the low-lying areas below the 10-foot contour level. The distribution of these wetland communities corresponds with varying degrees of surface and soil moisture and with major differences in soil salinity. The general characteristics of the vegetation types and their ecological groupings are summarized in Table 2. The details of composition and structure will be described later in this report.

Distribution of Vegetation Types at Santa Margarita

Figure 2 Appended shows the distribution of the major plant communities in the Santa Margarita study area. Wetland vegetation covers approximately 100 acres of this region. An additional 40 acres of lowland is periodically inundated by salt water at extreme high spring tides and by fresh water following winter rains. Under these conditions the growth of the vegetation is inhibited and the areas remain as barren salt-flats. The salt-flat south of the lagoon has long been used as a landing field for small aircraft and hence the present soil surface is much disturbed. Comparison of conditions now with an aerial photograph taken in 1955 show that the salt-flat area has increased by about 10% over the past 14 years. This suggests that the disturbance is also contributing to the barrenness of the area by eliminating pioneer plants.

Saltmarsh communities comprise over four-fifths (85 ac.) of the wetland vegetation in this study area. These communities lie below the extreme high spring tide level (7.8 ft.) and are subjected to varying lengths of tidal inundation. Two-thirds of this saltmarsh vegetation (55 ac.) comprises a very uniform pickleweed (Salicornia virginica) community that occupies the upper low to mid-littoral zone at approximately the mean high high water level. Towards the extreme high water level this community is replaced by a saltmarsh grassland community that covers approximately 29 acres of the study area. This community is variable in composition and has been much disturbed by human activity; in general, however, two fairly distinctive species associations can be distinguished. The grassland bordering the salt-flats comprises a mixture of weedy upland grass species with scattered glasswort (Salicornia subterminalis) and other characteristic saltmarsh species (eg. saltmarsh sandspurrey, alkali weed) on the lower margins. In contrast, the association fringing the inner border of the dunes is dominated by saltmarsh grass (Distichlis spicata ssp. stricta) interspersed with scattered individuals of goldenbush (Haplopappus venetus ssp. vernonioides). This association grades into an open sand-dune community on the seaward margin.

Bordering the inland fringe of the saltmarsh vegetation to the north is a transition zone between saltmarsh and fresh-water marsh. This comprises a Jaumea-rush Community of approximately 9 acres in extent. This community is dominated by Jaumea (Jaumea carnosa) and saltmarsh grass, with spiny rush (Juncus acutus var. sphaerocarpus) or yerba mansa (Anemopsis californica) becoming locally dominant in low lying areas within the community.

The remaining 5 acres of wetland vegetation occupy the edges of the slightly brack pond north of the lagoon (Sweetwater Pond) and the seepage area along the base of the northern bluff. Four-fifths of this fresh-water marsh comprises an emergent cattail-bulrush community. It is dominated by dense growths of cattails (Typha spp.) locally interspersed with California bulrush (Scirpus californicus) which may occasionally become dominant. Willow swamp occupies 1 acre of fresh-water marsh; this consists of almost pure stands of arroyo willow (Salix lasiolepis) or sand-bar willow (Salix hindsiana).

The gently sloping upland margins of the fresh-water marshland are bordered by a brush community dominated by goldenbush (Haplopappus venetus vernonioides). This forms a transition zone between the wetland vegetation and the coastal sage brush community that covers the adjacent bluffs. Where the bluffs descend steeply to the wetland margin, this brush fringe is absent. In the extreme north-west of the study area, the brush community is replaced by a dense thicket of giant reed (Arundo donax), a situation not observed in the other study areas.

Distribution of Vegetation Types at Las Flores

The distribution of the major vegetation types at this study area are shown in Figure 3 Appended. Only about 21 acres of wetland vegetation are present in this area and comparison with aerial photographs from 1955 indicate that most of the marsh in the drainage area to the north of the river has developed within the past 15 years. The existence of several acres of recently submersed soils in this northern area also indicates that the wetland acreage is gradually increasing.

Only 3.5 acres of wetland vegetation occur on the narrow borders of the Las Flores lagoon thus detailed studies were not made in this southern area. The vegetation types are shown in Figure 3 but the species present were not taken into account when making the check-list of this study area.

The detailed vegetation studies at Las Flores were all conducted in the northern drainage area. Approximately 18 acres of wetland vegetation is present, most of which (15.5 ac.) comprises fresh or brack-water marsh. The small acreage of pickleweed probably reflects the occurrence of local areas of hypersaline evaporite soils rather than the influence of tidal water although the area on the south side may be affected by the occasional entry of tidal water.

The major part of the fresh-water marsh comprises about 8 acres of cattail-bulrush community which occupies the areas of submersed soil. This community consists of a variable mixture of cattails, California bulrush and Olney bulrush (Scirpus olneyi); the cattails dominate the inland part of the drainage area (although one or other of the bulrushes may be locally abundant) while the bulrushes predominate in the seaward portion. A small stand (0.5 ac.) of willow swamp is present in the upper drainage region.

Approximately 4 acres of soil on the margin of the cattail-bulrush community appears to have been recently flooded by fresh water; this is occupied by an open pioneer community of rabbit-foot grass (Polypogon monspeliensis), brass-buttons (Cotula coronopifolia) and seedlings of cattails and curly-leaf dock (Rumex crispus). Much of this area has been disturbed and is criss-crossed by heavy-vehicle tracks. These track depressions form a broken series of miniature ponds containing a dense submergent cover of musk-grass (Chara sp.) or matted filamentous alga (Cladophora sp.). Elsewhere the fresh-water marsh grades into a brush community of goldenbush or a disturbed grassland community. On the south side of the drainage, the brush fringe community lies adjacent to an old-field community dominated by field mustard (Brassica campestris) and other weedy species, indicating that this low plain was formerly cultivated.

The pickleweed community in this study area is very different in structure from that at Santa Margarita. Although the dominant species is still Salicornia virginica, the vegetation cover is generally much less dense and is interspersed with small salt pans and artificial ponds. Part of this community is flooded by a shallow layer of fresh water. The upland edge grades into a thin cover of salt-flat grassland or a disturbed grassland community.

Distribution of Vegetation Types at San Mateo

Figure 4 Appended shows the composition and distribution of the vegetation types at San Mateo. Unlike the other two study areas, this region is heavily wooded by willow thickets (35 ac.) and riparian woodland (15 ac.). Although this area has been disturbed by road tracks and clearing in the past, the vegetation appears to have now reached a fairly stable disclimax over much of the area. Little recent human activity is evident and the region represents one of the finest stands of mature fresh-water marsh on the Southern California coast.

Approximately one-third (20 ac.) of the total wetland vegetation (65 ac.) comprises an emergent cattail-bulrush community. Three-quarters of this emergent community is dominated by California bulrush, occasionally mixed with cattails; the remaining one-quarter consists of almost pure stands of Olney bulrush. The cattail-bulrush community also occupies the margins of the willow swamp and appears to invade it following clearing. The mature willow community consists of almost pure stands of arroyo willow (Salix lasiolepis), an undercover being absent in most areas. On the upland margins, the willow swamp grades into thickets of shrubby willows or riparian woodland. Where these upland communities have been cleared, the tall vegetation is replaced by a dense brush community dominated by coyote-brush (Baccharis pilularis consanguinea), weeds and scattered coastal shrubs (eg. Salvia mellifera, Artemisia californica).

The remaining wetlands vegetation comprises approximately 8 acres of emersed soil communities. Half of this acreage consists of a Jaumea-rush Community, similar in general structure to that at Santa Margarita but with Mexican rush (Juncus mexicanus) forming a thin upper canopy rather than spiny rush. This community fringes the bulrush communities on the inland border of the marsh and behind the dune barrier. In the latter area it grades into an upland brush community of low coyote-brush in which the Mexican rush frequently persists as an undercover. Where the Jaumea-rush Community has been heavily disturbed (possibly cleared and cultivated), it is replaced by a very variable community of weedy species (predominantly celery, salt-marsh fleabane and an unidentified Composite) with an undercover of jaumea, yerba mansa and spike-rush (Eleocharis montevidensis).

On the north-west side of the riparian community is a low sand bar bordering the southern bank of the river. This carries a very open pioneer community of low herbs (predominantly common monkey-flower and speedwell) and small rushes (Eleocharis and Juncus spp.). Temporary ponds hold a submergent cover of pondweed (Potamogeton pectinatus) and grass-wrack (Zannichellia palustris). The presence of abundant willow seedlings indicates that this area will ultimately be replaced by willow thickets.

Flora

Exhibits A, B, and C appended, comprise check-lists of the wetland species present in the Santa Margarita, Las Flores and San Mateo study areas respectively. The species are grouped into non-flowering plants, monocots and dicots; the families and species in each group are listed in alphabetical order. The check-lists include notes on the relative abundances of the species and their ecological affinity within each study area. A total of 72 species were recorded at Santa Margarita, 57 at Las Flores and 58 at San Mateo. The differences in the floristic composition of the three areas largely reflects the prevailing salinity conditions: saltmarsh species predominate at Santa Margarita; fresh-water species at San Mateo; the Las Flores area comprises a variable mixture of both floral groups. The large proportion of weedy species in all areas reflects the disturbed nature of many of the communities.

Community Composition and Structure

Details of the composition and structure of the wetland plant communities can be assessed from the relative abundances and percent cover sampled in the belt transects. Relative abundance values are estimates of the density of the individual species while the percent cover, when correlated with the average height of the plants, provides a good indication of the influence exerted by each species comprising the community. The belt transect data also serves as a yardstick against which to measure changes in the community with time.

Santa Margarita Study Area

Table 3 shows the results of the belt transect sampling at Santa Margarita. Transect I ran from the west shore of Sweetwater Pond to the summit of the dune barrier, crossing the upper end of a small tidal inlet. The shoreline of the pond showed a marked vertical succession of species and was thus sampled at meter intervals. Along the rest of the transect, however, the communities showed a high degree of uniformity and were only sampled at 50 ft. intervals.

The first three quadrats show the composition of a typical Jaumea-rush Community of the Santa Margarita area; this formed a distinctive belt along the shore of the pond, with the Juncus occurring along a contour line about 6 ft. above the water level. Quadrats 4 to 9 lay above this belt and represent the vegetation of a highly disturbed saltmarsh grass association resulting from the presence of a road-track through the area. Most of the species present are characteristic of the weedy element of the saltmarsh vegetation; many of them occur sporadically throughout the wetland area without forming a distinctive community. Quadrats 10 and 11 represent typical stands of the pickleweed community while quadrat 12 shows the composition of the saltmarsh grassland fringing the inland edge of the dunes. This community is characterized by the abundance of Distichlis and the presence of low-growing shrubs, predominantly Haplopappus or occasionally Lotus scoparius (as in Area C). This grassland community appears to represent a transition from the littoral saltmarsh region to the maritime region (spray zone) above it.

Transect II extended from the margin of the lagoon across the pickleweed and Jaumea-rush Communities to the southern fringe of the Cattail-bulrush Community. A small temporary brack-water pond bisected the transect line between 200 and 260 ft. allowing the invasion of a sparse stand of emergent vegetation into the saltmarsh (see quadrats 10 - 13). Stations 1 to 8 represent the structure and composition of a typical pickleweed community which is generally dominated throughout, both in density and cover, by Salicornia virginica. Towards the lower edge (Sta. 1) Salicornia occurs in almost pure stands but towards the upper levels of the mid-littoral zone, Distichlis and Frankenia enter the community as subdominants, occasionally becoming locally dominant in areas of slightly increased elevation.

Stations 15 - 18 represent a marked change in species abundance in the Jaumea-rush Community which forms a transition zone between the Saltmarsh Community and the Fresh-water Cattail-bulrush Community. Although some of the saltmarsh species persist in this community, they remain subordinate to Jaumea while a few of the typically fresh-water species from the Cattail-bulrush Community (eg. Apium and Scirpus olneyi) appear in small quantities. Stations 20 - 22 show the composition of the Cattail-bulrush Community which is typically dominated by tall stands of Typha domingensis or Typha latifolia below which is a heavy cover of litter (Sta. 22). Toward the margin of this community the composition becomes variable as wetland weeds (eg. Apium and Pluchea) enter the undercover. The fringe community is typically two-layered: Typha and Scirpus species dominate in height while the shorter undercover species frequently dominate in density.

Las Flores Study Area

Table 4 summarizes the composition and structure of the communities sampled in the transect areas. Transect I extended from the disturbed grassland border on the northern edge of the study area across the wetlands to the brush fringe on the east side. Transect II ran from the center of the Northern Pickleweed Community westward across the Cattail-bulrush Community to the inland edge of the low dune barrier.

Quadrats 1 - 3 of Transect I show the composition of a typical stand of disturbed grassland on the upland border of the wetlands. Low-growing weedy grass species predominate along with a mixture of weedy herbs. Quadrats 5 - 8 represent the composition of the Cattail-bulrush Community in this area while Quadrats 4 and 9 are characteristic of the fringe community. The structure of the community is similar to that at Santa Margarita although the species composition in the undercover is rather different. Quadrats 10 - 12 represent the pioneer floodland community of the inland region of the study area. Much of the community comprises small open pools fringed by a sparse cover of Polypogon and Epilobium. Elsewhere, Cotula and Juncus bufonius are common components of this community. Young seedlings of Typha and other wetland plant species are frequently found in the pools. The litter comprises dead Brassica stalks or Haplopappus branches, remnants of the pre-flooding community, the composition of which was probably similar to that in quadrat 13.

Stations 1 - 7 of Transect II show the relative abundance and cover of the species in the Pickleweed Community. The composition of this community is conspicuously different from that in the saltmarsh at Santa Margarita and brackish surface water is present over most of the area, forming small ponds in places. The community appears to represent a modification of a saline pan community as a result of recent flooding.

The Pickleweed Community gives way abruptly to a submersed soil Cattail-bulrush Community at Station 8. This community exists in two phases represented by Sta. 9 - 11 and 12 - 15 respectively. The first four stations are dominated by Scirpus olneyi while the remaining stations are dominated by Typha, with the Scirpus forming a tall undercover layer. On the seaward margin, the Cattail-bulrush Community gives way to a pioneer Floodland Community (Sta. 15 & 16) similar to that described for Transect I.

San Mateo Study Area

The results of the belt-transect sampling are recorded in Table 5. Transect I extends from the inner edge of the dune barrier across a small emersed-soil Cattail-bulrush Community to the lower edge of the brush fringe on the east side. Transect II extends from the railroad embankment across a submersed-soil Cattail-bulrush Community.

The first 4 quadrats of Transect I reflect the composition of the Upland Communities on the seaward margin of this study area. The sparse, open Dune Community gives way abruptly to Coyote-brush scrub that fringes the wetland basin. The Brush Community in turn gives way sharply to a zone of jaumea-rush (quadrats 5 - 7) that occupies the damp emersed soils on the upland fringe of the Cattail-bulrush Community. The Jaumea-rush Community here differs from that at Santa Margarita in that Juncus mexicanus forms the upper layer instead of Juncus acutus. At Area A, on the inland side of the San Mateo study area, yet another variation occurs viz. the appearance of Carex in the upper layer; this seems to be correlated with local areas of drier soil. (see data for Sample Area A).

Quadrats 9 and 10 show the simple composition of the Cattail-bulrush Community in this area. Scirpus californicus dominates in approximately 80% of this community west of the railroad, possibly reflecting a greater salinity tolerance than the other characteristic species of this community. Quadrats 8, 11 to 13 represent the more variable composition of the margins of this community. The remaining quadrats cover the Jaumea-rush fringe on the eastern border of the wetland basin; the more variable composition reflects the presence of an upland weed flora on the disturbed soils of the railroad embankment.

Transect II samples two aspects of the Cattail-rush Community. Typha dominates the first three quadrats while the remaining transect area was dominated by an almost pure stand of Scirpus olneyi. There was no obvious difference in the environmental conditions to explain the segregation of these two associations.

Table 5 appended, also includes the sampling data for the disturbed communities at Areas B and C. The former represents a cleared willow swamp area that has now been invaded by Scirpus olneyi. The composition of the present community is essentially the same as that of undisturbed Scirpus associations. In contrast, the community now present in a disturbed Jaumea-rush Community at Area C is totally unlike that in any other part of the study area. The abundance of weedy species and seedlings suggest that this area has been cleared in the recent past but it is not obvious what pattern of development will occur in the future.

Soil Studies

Tables 6, 7 and 8 appended, summarize the results of the soil analyses for the Santa Margarita, Las Flores and San Mateo study areas respectively. Insufficient time was available to interpret these results.

CONCLUSION AND RECOMMENDATIONS

Comparison of the marshland vegetation present in the three study areas with that described in the literature reveals some interesting patterns of similarity and contrast. The saltmarsh vegetation at Santa Margarita is basically similar to that described at Los Penasquitos Lagoon (Bradshaw 1968). Both these saltmarshes differ from the marshes at Mission Bay (Macdonald 1967), Newport Bay (Vogel 1966) and San Francisco Bay (Hinde 1954) in showing an absence of a submergent Eelgrass (Zostera) Community, lower littoral Spartina Community and a Salicornia bigelovii - Batis Association around the mean high water level. The absence of these communities is most likely the result of the limited tidal action in these lagoons since the zonation of saltmarsh species appears to be critically controlled by the length of the periods of tidal submergence or emergence (Macdonald 1969). Once the sand bar at the mouth has built up to a height above that of the mean high water level, the lower littoral communities become permanently submerged and cut off from an adequate oxygen supply. In addition, the lowering of the surface water salinity that follows closure may inhibit the growth of some of the species eg. Zostera and Salicornia bigelovii.

The Santa Margarita saltmarsh differs slightly from that at Los Penasquitos in the absence or extreme rarity of several characteristic mid and upper littoral species. These include Monanthochloe littoralis, Suaeda californica and Limonium californicum. This possibly reflects the high degree of disturbance in the upper littoral region.

Despite the present depauperate nature of the Santa Margarita saltmarsh, this area has the potential for the development of a valuable estuarine habitat. The large acreage of low lying saltflat both north and south of the river would be ideal areas for the excavation of a series of ponds and channels. Essentially, this operation would simply restore the old channels that formerly drained the marsh. This would increase the tidal prism of the lagoon and consequently aid in keeping open the lagoon mouth. Tidal conditions in the lagoon also significantly aid in flushing out excess nutrients that lead to serious eutrophication and pollution problems in several of the small non-tidal lagoons south of Oceanside.

The results of maintaining adequate tidal flushing in the Los Penasquitos Lagoon illustrate the dramatic improvements that are likely to ensue in the Santa Margarita area. The fish population increased from 5 to 17 species, including halibut, corbina and sculpin. Oysters, clams, cockles and shrimp became established on the mudflats and an abundance of shorebirds and waterfowl were subsequently attracted into the area. Similar changes occurred at Agua Hedionda following the opening of the lagoon mouth (Miller 1966). The mollusc species rose from 0 to 73 including a wide variety of edible clams and scallops and beds of eelgrass formed in the lagoon attracting a wide variety of waterfowl.

Similarly, despite the disturbed nature of the freshwater marsh in the study areas, these also offer opportunities for significant improvement of the wildlife value. At present their value is reduced by the density of the emergent vegetation which is a result of the shallow surface water levels in these areas. Excavation of the soft mucky clays to a depth of three or more feet would prevent the colonization of the open water by cattails and bulrushes and allow the development of a submergent vegetation of high waterfowl food value eg. Potamogeton pectinatus in fresh water, and Ruppia maritima in brackish water. The excavated soil could possibly be used to form clayey emersed soil areas on the upper fringe of the Cattail-bulrush Community; this would likely increase the acreage of the Jaumea-rush Community that forms an important nesting habitat for waterfowl.

In view of the paucity of studies of the coastal Californian fresh-water marshes, it is strongly recommended that studies be continued in these areas to provide a more comprehensive analysis of community structure and succession. Surface and soil water levels should be measured over at least 12 months to gain a better understanding of how these affect the species distribution. Only by obtaining more information on the relationship between these factors and the soil salinity and structure can an accurate picture of the vegetation patterns and species distributions be constructed.

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REFERENCES

Bolen, Eric G. (1964). Plant Ecology of Spring-Fed Salt Marshes in Western Utah. Ecol. Monog. 34: 143-166.

Brown, W. S. and C. Cottam (1950). Some Biological Effects of Ditching Tidewater Marshes. U. S. Fish and Wildlife Service Research Report 19, Washington, 30 pp.

Bradshaw, John S. (1968). Report on the Biological and Ecological Relationships in the Los Penasquitos Lagoon and Salt Marsh Area of the Torrey Pines State Reserve. California Division of Beaches and Parks. Contract No. 4-05094-033.

Chapman, V. J. (1960). Salt Marshes and Salt Deserts of the World. Interscience Publishers Inc. N.Y.

Daubenmire, R. (1968). Plant Communities: A Textbook of Plant Synecology. N.Y., 300 pp.

Ellis, A. J., and C. H. Lee (1919). Geology and ground waters of the western part of San Diego County, California. U. S. Geological Survey Water Supply Paper 446; 1-32.

Gannon, R. and I. Nusbaum (1967). Eutrophication of San Elijo Lagoon, San Diego County, 1966-67. Report submitted to San Diego Regional Water Quality Control Board (No. 9).

Gorsline, D. S. (1967). Contrasts in Coastal Bay Sediments on the Gulf and Pacific Coasts. In: Estuaries, G. H. Lauft (ed.). AAAS Publication #83, Wash., pp. 219-225.

Harris, S. W. and W. H. Marshall (1963). Ecology of Water-Level Manipulations on a Northern Marsh. Ecology 44 (2):331-343.

Higgins, E. B. (1949). Annotated Distributional List of Ferns and Flowering Plants of San Diego County. San Diego Society of Natural History Occasional Paper No. 8.

Hinde, Howard P. (1954). The Vertical Distribution of Salt Marsh Phanerogams in Relation to Tide Levels. Ecological Monographs 24: 209-225.

Jennings, J. N. and Bird, E.C.F. (1967). Regional Geomorphological Characteristics of Some Australian Estuaries. In: Estuaries, G. H. Lauft (ed.). AAAS Publication #83, Wash., pp. 219-225.

Keith, L. B. (1961). A Study of Waterfowl Ecology on Small Impoundments in South-eastern Alberta. Wildlife Monographs No. 6, 88 pp.

MacDonald, K. B. (1967). Quantitative Studies of Salt Marsh Mollusc Faunas from the North American Pacific Coast. Ph.D. Thesis, University of California, San Diego.

Mason, H. L. (1957). A Flora of the Marshes of California, Univ. of Calif. Press, Berkeley and Los Angeles, 878 pp., illus.

McDonald, M. E. (1955). Cause and Effects of a Die-Off of Emergent Vegetation. Journal of Wildlife Management 19: 24-35.

Miller, J. N. (1966). The Present and the Past Molluscan Faunas and Environments of Four Southern California Coastal Lagoons. Master Thesis.

Munz, P. A. (1959). A California Flora. Univ. of Calif. Press. Berkeley and Los Angeles. 1681 pp., illus.

Penfound, W. T. and E. S. Hathaway. (1938). Plant Communities in the Marshlands of Southeastern Louisiana. Ecological Monographs 8: 1-56.

Purer, E. A. (1942). Plant Ecology of the Coastal Salt Marshlands of San Diego County, California. Ecological Monographs 12: 83-111.

Reid, G. K. (1961). Ecology of Inland Waters and Estuaries. N.Y. 375 pp.

Sculthorpe, C. D. (1967). The Biology of Aquatic Vascular Plants. St. Martin's Press, N.Y.

Smith, R. L. (1966). Ecology and Field Biology. N.Y. pp. 686.

Stevenson, R. E. and K. O. Emery. (1958). Marshlands at Newport Bay, California. Allan Hancock Foundation Occasional Paper No. 20.

U. S. Dept. of Interior Geological Survey. (1967). Water Resources Data for California Surface Water Records. Pt. 1, Vol. 1.

Vogel, R. J. (1966). Salt Marsh Vegetation of Upper Newport Bay, California. Ecology 47: 80-87.

APPENDICES

FIGURES

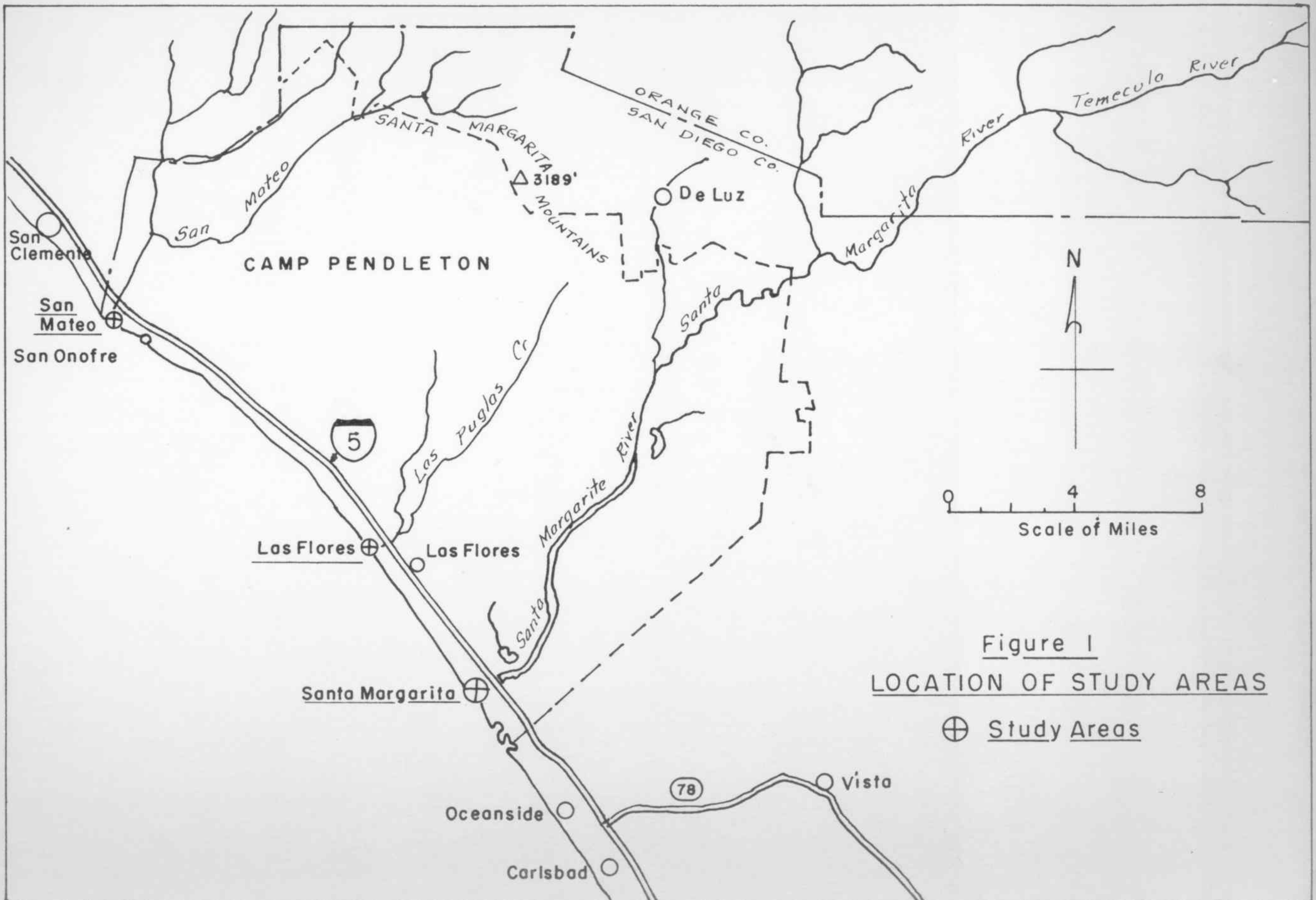

Figure 1
LOCATION OF STUDY AREAS

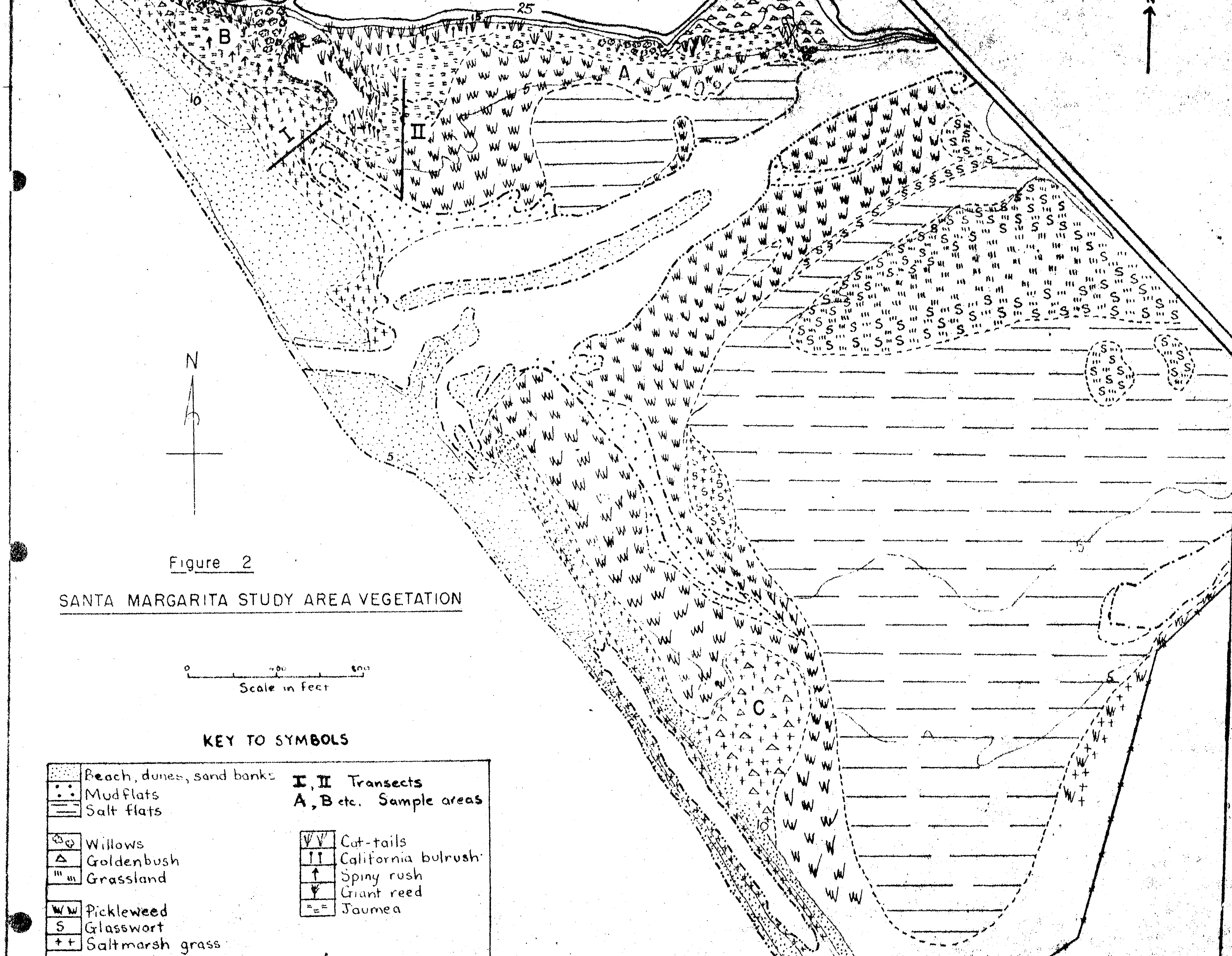

Figure 2

SANTA MARGARITA STUDY AREA VEGETATION

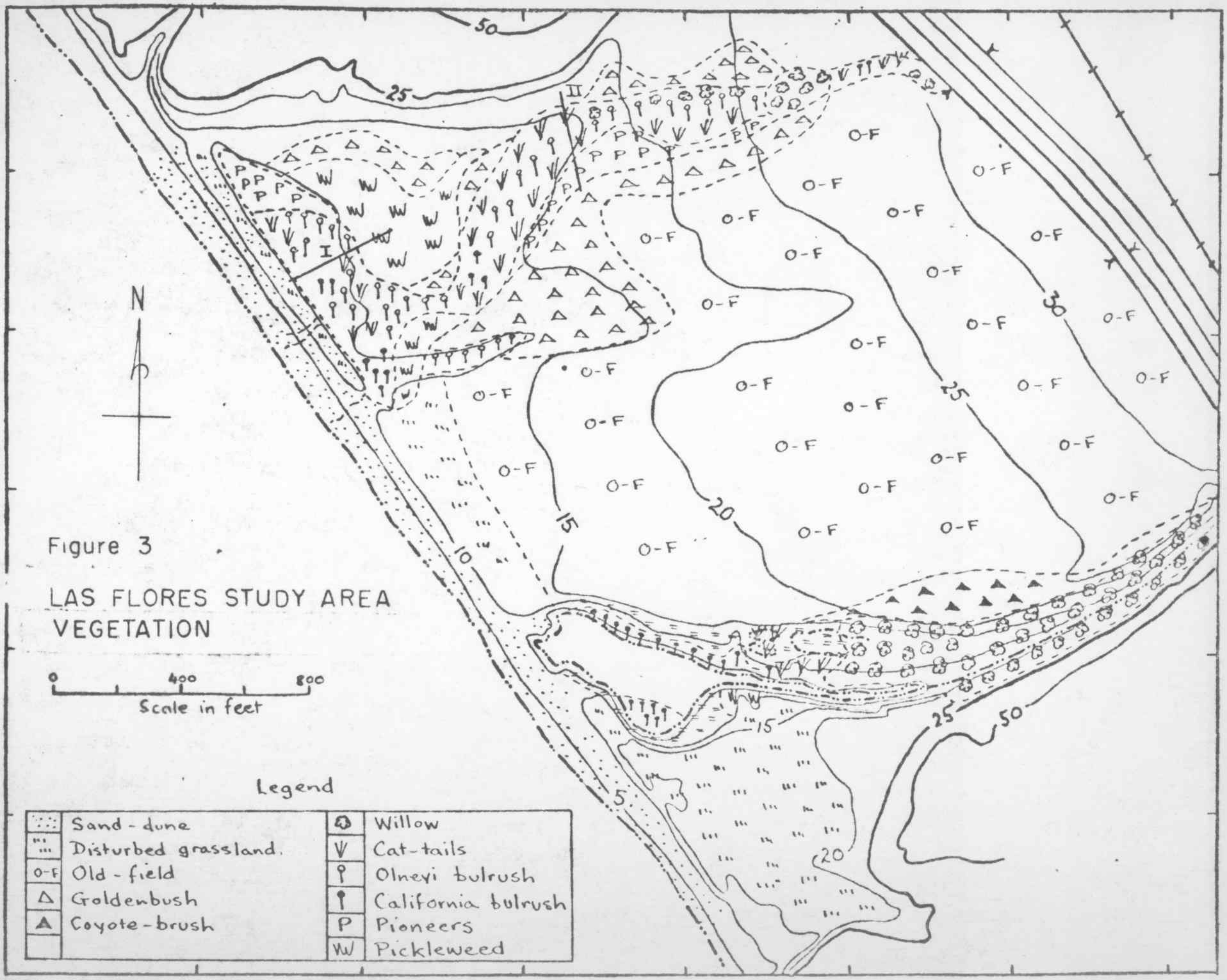

Figure 3

LAS FLORES STUDY AREA
VEGETATION

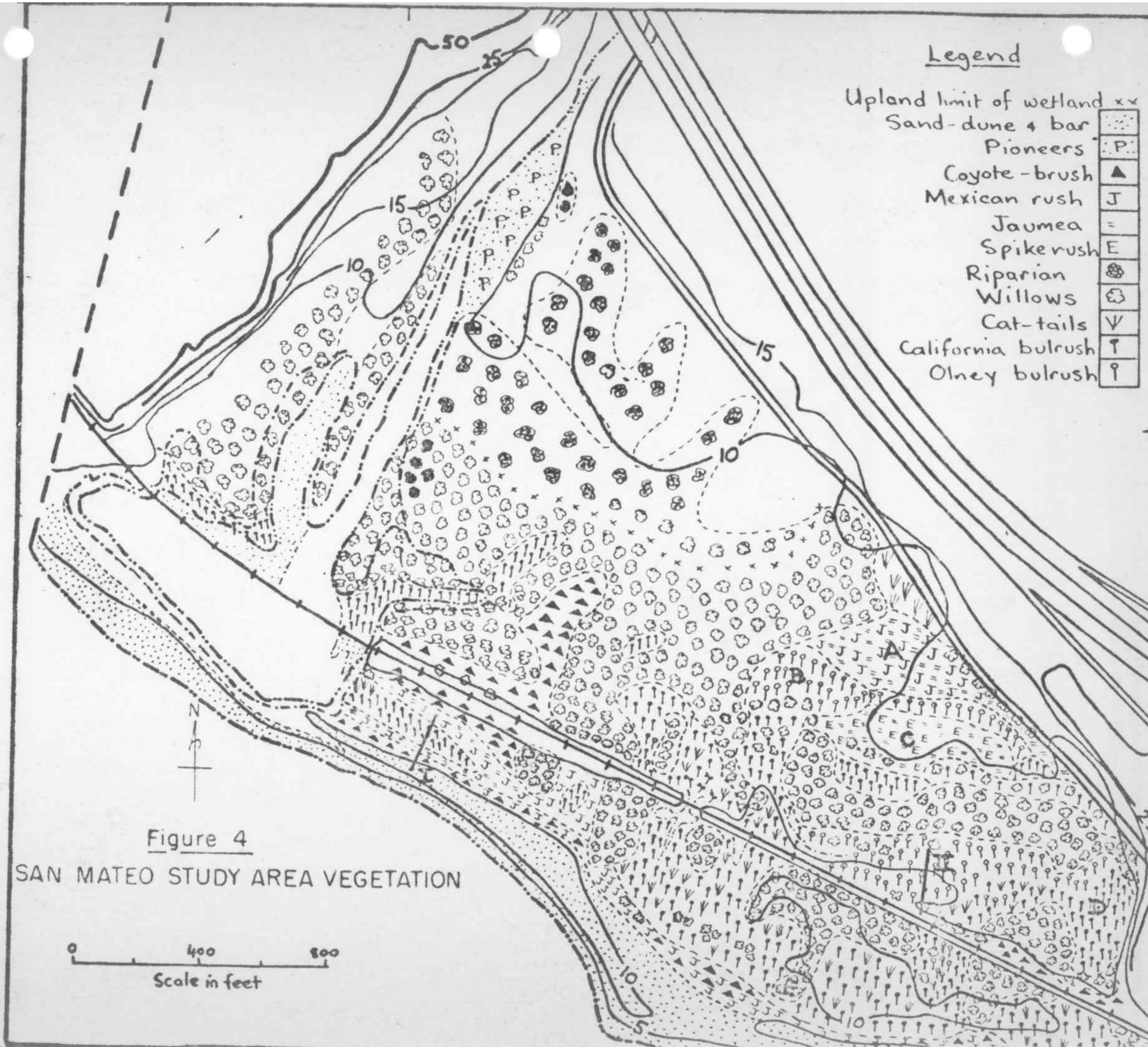

Figure 4
SAN MATEO STUDY AREA VEGETATION

TABLES

TABLE I

SURFACE WATER RECORDS FOR RIVERS IN STUDY AREAS

	Santa Margarita 1/	Las Flores 2/	San Mateo 3/
Drainage area (sq.mi.)	739	26.6	132
Average discharge (c.f.s.)	27.2	0.74	5.53
Median of yearly mean discharge (c.f.s.)	8.4	0.34	0.04
Maximum discharge (c.f.s.)	33,600 4/ (2/16/27)	960 (1/16/52)	10,000 4/ (12/5/66)
Maximum discharge 1966-67 (c.f.s.)	1,720 (12/7/66)	848 (12/6/66)	2,760 (12/5/66)
Minimum discharge (c.f.s.)	0 part of most years	0 most of each year	0 all or several mo. of each yr.

Notes: Source of data: U. S. Dept. Interior, Geol. Survey, 1967

1/ Gauging station 2.5 mi. upstream from mouth, records over 44 yrs.

2/ Gauging station 0.5 mi. upstream from mouth, records over 16 yrs.

3/ Gauging station 0.8 mi. upstream from mouth, records over 21 yrs.

4/ Due to failure of detention dam

TABLE 2

SUMMARY OF VEGETATION TYPES

A. Wetland Communities

Plant Community	Vegetation Type	Characteristics
1. Pickleweed	Saltmarsh, mid-littoral zone	Dense cover of pickleweed (Salicornia); average height 12"; very uniform composition
2. Saltmarsh grass-land	Saltmarsh, upper littoral zone	Medium to dense cover of low growing grasses and herbs, scattered prostrate or low growing shrubby herbs; variable in composition
3. Jaumea-rush	Brackish/fresh-water march, emersed soil zone	Very dense cover of low-growing Jaumea (Jaumea carnosa) inter-spersed with taller rushes (Juncus spp.) or yerba mansa (Anemopsis californica), frequently with undercover of saltmarsh grass (Distichlis)
4. Disturbed Jaumea-rush	Fresh-water marsh, emersed soil zone	Dense cover of weedy species with Jaumea, yerba mansa and spike-rush (Eleocharis) forming an undercover; very variable in composition
5. Cattail-bulrush	Fresh-water marsh, submersed soil zone	Dense cover of cattails (Typha spp.) and bulrushes (Scirpus spp.); average height 6 ft.; variable in composition and undercover
6. Willow	Fresh-water swamp, submersed to emersed soil zone	Dense cover of tall shrubby willows (Salix spp.); sparse or no undercover; average height 20 ft.; very uniform in composition
7. Pioneer	Pioneer succession stage, salt and fresh-water marsh, submersed/emersed soils	Sparse cover of seedlings, annual or short-lived perennial herbs; average height less than 12"; composition varying with salinity and soil but fairly uniform within each area

Table 2 Continued

B. Upland Communities

8.	Brush	Coastal scrub	Medium to dense cover of low shrubs dominated by goldenbush (Haplopappus venetus) or coyote-brush (Baccharis pilularis); composition of undercover variable
9.	Sand-dune	Coastal dune	Sparse cover of mat-forming herbs dominated by beach suncup (Oenothera cheiranthifolia) beach sand verbena (Abronia umbellata) and sand bur (Franseria bipinnatisecta)
10.	Disturbed grass-land	Low grassland	Medium to low cover of weedy grasses and annual herbs; variable composition
11.	Old-field	Old-field	Medium to dense cover of tall annual weedy spp., dominated by field mustard (Brassica campestris); scattered pioneer shrubs from the coastal scrub
12.	Riparian	Woodland	Dense cover of trees dominated by white alder (Alnus rhombifolia), cottonwood (Populus) and willows (Salix); heavy underbrush of willows, shrubs and perennial herbs.

TABLE 3

SANTA MARGARITA VEGETATION ANALYSES

Transect I

Quadrat #	1	2	3	4	5	6	7	8	9	10	11	12
Distance from 0 (ft)	0	3.3	6.6	9.9	13.2	16.5	19.8	23.1	26.4	70	120	170
Water level (ins.)	-2	- - - - - - - - lower than 6 - - - - - - - - - - - - - - - -										
Litter (% cover)						29	83		12	25	10	
Bare ground (%)						5		50	10		3	
Open water (%)												
Jaumea carnosa	va/75	va/90	va/75	va/55	va/33					r/tr	o/2	a/30
Distichlis spicata stricta	a/25	a/10	a/25	a/10				r/tr		r/tr	va/55	va/35
Atriplex patula hastata	r/tr	r/tr										
Juncus acutis		r/33	r/25									
Apium graveolens		r/tr	r/tr									
Melilotus indicus		r/tr	o/12	r/tr		r/tr	f/ND	o/5			o/1	r/tr
Heliotropium curassavicum		r/tr		f/25	a/25	a/30		f/10	0/20			
Ambrosia psilostachya				f/20	f/50	a/35	a/40	a/25				
Lepidium sp.							r/tr	r/tr	a/13			
Frankenia grandifolia							f/25		o/25	a/25	r/1	
Cakile edentula									r/tr			
Mesembryanthemum chilense									o/25			
Salicornia virginica										va/53	f/30	
Sonchus oleraceus											r/tr	
Atriplex watsonii												f/10
Haplopappus venetus												r/25

Transect I continued

Quadrat #	13	14	15
Distance from 0 (ft)	220	270	320
Water level (ins)	lower than 6"		
Litter (% cover)			
Bare ground (%)	15	98	60
Open water (%)			
Franseria chamissonis	o/75		
Abronia umbellata	r/5		r/20
Oenothera cheiranthifolia	r/2	o/1[1]	o/15
Cakile edentula		r/tr	o/15
Melilotus indicus	o/2		
Lepidium sp.	f/3		
Nemacaulis denudata		f/1	

1 seedlings

Table 3 continued

Transect II

Station #	1	2	3	4	5	6	7	8	9	10	11	12	13
Distance from 0 (ft)	0	20	41	60	80	100	120	140	180	200	226	240	260
Water level (ins.)	– – – –	– – – –	– – – –	– – – –	– – – –	lower than 12	– – – –	– – – –	– – – –	– – – –	– – – –	– – – –	– – – –
Litter (% cover)	13												70
Bare ground (%)			2				3	15[2]	68		50	10	
Open water (%)													
Salicornia virginica	va/87	va/90	va/93	a/50	a/30	r/2	a/35	va/80	a/20	o/8	a/10[3]	r/tr[3]	o/[illegible]
Distichlis spicata stricta		a/10	f/5	a/35	va/60	a/30	a/30	f/3	a/12	a/35	a/25		
Frankenia grandifolia			f*	f/12	a/30	va/65				a/50		va/85	
Melilotus indicus						o/2							
Jaumea carnosa						f/2	o/5			a/50		o/1[3]	
Juncus acutis						r*	r/75	r*					
Atriplex patula hastata							o/tr[3]						f/2
Scirpus robustus										r*			
Scirpus californicus											f/15	f/15	
Typha latifolia											r*		
Chenopodium macrospermum												r/tr[3]	

Transect II continued

Station #	14	15	16	17	18	19	20	21	22
Distance from 0 (ft)	280	320	360	380	400	420	440	480	500
Water level (ins)	– – – –	lower than 6	– – – –	– – – –	– – – –	– – – –	0	+1	0
Litter (% cover)							40		90
Bareground (%)								5	
Open water (%)								15	
Salicornia virginica	va/65	a/25	a/30	o/2	r/tr		o/8		
Distichlis spicata stricta	a/10	a/25	a/15	a/15	f/8				
Frankenia grandifolia			a/30	o/2	va/65				
Jaumea carnosa	a/25	va/50	va/50	va/90	a/35				
Atriplex patula hastata						a/95	tr[3]	o/12	
Typha latifolia								r/5	
Cuscuta salina[4]	/5	/tr	/2	/25	/tr				
Apium graveolens			r*				r/10	o*	
Scirpus olneyi				r/tr	r/tr	o/5	f/20	f/30	
Typha domingensis							o/12	a/30	a/60
Pluchea purpurascens							r/8	r/1[5]	
Heliotropium curassavicum							r/tr		
Convolvulus sepium[4]							o/4	o*	o/1

* present but not in quadrat
1 tire track at 40'
2 overturned sods of soil
3 seedlings
4 twining on other plants
5 dead

TABLE 4

LAS FLORES VEGETATION ANALYSES

Transect I

Quadrat #	1	2	3	4	5	6	7	8	9	10	11	12	13
Distance from O (ft)	0	40	60	80	100	120	140	150	160	180	200	225	285
Water level (ins.)	- 8	-39			0	+2	+3	+5	+3	+1	0→+1	0	-12
Litter (% cover)				15	15	10	15	40					
Bare ground (%cover)											50	80	3
Open water (% cover)					30					30	20	3 7	
Bromus mollis	a/15	a/35	a/35										
Bromus rubens	f/20	a/40	a/40										
Medicago hispida	f/30	o/15	o/2										
Avena fatua	o/15	f/5	o/5										
Festuca sp.	f/5												
Erodium cicutarium	o/10												
Raphanus sativus	r/tr	r/5	r*										
Malva parviflora	r/tr	r/tr		r/tr							-/5	r/1	
Atriplex semibaccata	r/tr												
Haplopappus venetus	r*		r*						o/45[2]				r/10
Melilotus indicus		r/tr	o/25							o*	o*		f/60
Brassica campestris			o/5								r/tr		r/2
Sonchus oleraceus			r/tr					r*					
Rumex crispus				f/25	o/15	o/15	o/20	r/5	r/2	r*	o*		
Picris echioides				r/12	r/tr								
(seedlings)				f/40									
Baccharis pilularis				r/30									
Solanum sp.				r/tr									
Epilobium adenocaulon				r/tr	o/5	f/50			a/95	f/15[1]	r/5	r/4	r/tr
Pluchea purpurascens				r*	r/tr[1]		o/10						
Typha latifolia					o/15	O/40	o/30	f/80	r/1[2]	r/tr	o/1[1]	o/1[1]	
Eleocharis palustris					a/5								
Lemna sp.					f/tr								
Polypogon monspeliensis					r/tr	r*		r/3	r/2	o/3	o/20		
Scirpus olneyi						r/tr		o/tr					
Eleocharis montevidensis							va/20	f/tr					
Cotula coronopifolia									r*				
Lolium perenne										r*			
Juncus bufonius											o*		

* outside of quadrat
1 seedlings
2 plants dead

Table 4 continued

Transect II

Station #	1	2	3	4	5	6	7	8	9	10	11
Distance from 0 (ft)	0	20	40	60	80	100	120	140	160	180	200
Water level (ins.)	+2	+8	+½	-2	0	+2	+2	+3	+4	+6	+3
Litter(% cover)			5								
Bare ground (%)				5	1						
Open water (%)	20	5						8	15	5	2
Salicornia virginica	a/40	a/25	va/80	va/90	va/99	a/45	va/70				
Cotula coronopifolia	a/20	f/4	o/tr			f/3	f/4	a/12	a/50	o/ND	r/tr
Polypogon monspeliensis	o/5	r/tr	o/2	f/5	r/tr	f/18		f/20			-/3
Spergularia marina	r/tr										
Typha seedlings	r/tr	r*	r/tr								
Enteromorpha sp.	/25	/50									
Eleocharis macrostachya		va/70									
Atriplex patula hastata		o/tr	r/tr								
Lemna valdiviana		/tr							/tr		r/tr
Rumex crispus		f/2¹							r/1		
Cladophora sp.			/10			/34	/25				
Frankenia grandifolia				r/tr							
Scirpus olneyi								va/80	va/75	va/95	va/95
Typha latifolia									r/1		

Transect II continued

Station #	12	13	14	15	16
Distance from 0 (ft)	226	246	266	286	312
Water level (ins)	+5	+6	+2	+2	+6
Litter (% cover)					
Bare ground (%)					5
Open water (%)	8	25			
Cotula coronopifolia	f/25	f/5	?²	o/1	a/10
Polypogon monspeliensis	f/3	f/8	f/20	a/30	a/15
Spergularia marina					r/tr
Enteromorpha sp.					/20
Atriplex patula hastata	r/tr		r/tr		r/tr
Lemna valdiviana	/tr	/tr			
Rumex crispus	o/7	r/2	o/20		
Scirpus olneyi	va/65		f/25		f/2¹
Typha latifolia		o/30		r/1	
Typha domingensis	r/5		o/15		
Scirpus californicus	f*	o/10			
Melilotus indicus			r/tr		
Sida hederacea¹			r/tr		
Sonchus oleraceus¹				r/tr	
Eleocharis montevidensis					-/2
Chara sp.					/50

* present but not in quadrat
1 seedlings
2 present but not counted

TABLE 5

SAN MATEO VEGETATION ANALYSES

Transect I

Quadrat #	1	2	3	4	5	6	7	8	9	10	11	12
Distance from 0 (ft)	0	20	40	60	70	80	90	100	110	120	130	140
Water level (ins.)												
Litter (% cover)			12							100	90	
Bare ground (% cover)	76	40	37	6								
Open water (%)												
Oenothera cheiranthifolia	r/23	r/tr										
Cakile edentula	r/1											
Baccharis pilularis		r/40	r/50	r/85								
Anagallis arvensis		o/20	o/1	r/tr								
Brassica nigra		r/tr										
Nicotiana sp.		r/tr										
Gnaphalium sp.		r/tr										
Frankenia grandifolia			r/tr									
Atriplex lentiformis				r/8								
Jaumea carnosa					va/99	va/90	va/95	va/95	f/50			
Juncus mexicanus					va/35	va/50	f/5					
Scirpus californicus						f/15	f/20	a/35	va/80	va/80	o/20	f/30
Composite A											o/25	a/70

Quadrat #	13	14	15	16
Distance from 0 (ft)	150	160	170	190
Water level (ins.)				
Litter (% cover)				
Bare ground (%)				
Open water (%)				
Baccharis pilularis	r*			
Jaumea carnosa		va/90	va/90	a/45
Juncus mexicanus		va/18	va/35	a/18
Composite A	va100			
Urtica holosericea	f*			
Rosa californica	o*			
Sonchus asper		r/3		
Cuscuta salina		a/35	o/10	
Anemopsis californica		r/3	o/15	o/65

* outside of quadrat
1 seedlings
2 twining around _Jaumea carnosa_

Table 5 continued

Transect II

Quadrat #	1	2	3	4	5	6	7	8	9	10	11	12
Distance from 0 (ft)	0	20	40	65[1]	80	100	120	140	160	172	192	212
Water level (ins.)	+10	+10	+9	+3	+7	+7	+6	+5	+3	0	0	0
Litter (% cover)	40	15	20			100	100	100	100	100	100	100
Bare ground (%)												
Open water (%)	34	45	15									
Polygonum coccineum	o/25	o*	r/10	f/60	r/5	r/3	r/5	r/5				
Typha	r/1	o/50	o/55[2]									
Scirpus californicus		o-la*										
Scirpus olneyi			r/tr	a/40	va/90	a/40	a/30	a/30	va/80	va/80	a/50	a/60
Salix lasiolepis											-/tr	r/30

* outside of quadrat
1 pile of dead tree trunks at 60 ft.
2 two-thirds of the plants dead

Sample Area A

Method: Systematic sampling along a line at approximately 10' intervals, using a rectangular quadrat (0.5 x 0.25 m) 0.125 m^2 in area.

Quadrat #	1	2	3	4	5	6	7	8	9	10	11
Water level (ins.)	-6	-6	-4	-4	0—+1	+1	0	-2	0	ND	- 6
Litter (% cover)											
Bare ground (%)									15		
Open water (%)						5					
Jaumea carnosa	a/80	a/30	a/80	a/70	a/80	a/75	a/75	va/75		va100	o/10
Juncus mexicanus	f/12	o/5	f/20	a/30	a/25			o/3			
Distichlis spicata	va/90	va/90	va/90	va/90	va/90	r/tr					a/75
Anemopsis californica		r/2		r/2	r/tr	r/15	o/10	o/20	f/85		r/tr
Carex praegracilis					r/tr						va/75
Scirpus olneyi							r/tr				
Salix lasiolepis					r*						

* outside of quadrat

TABLE 6

SANTA MARGARITA SOIL ANALYSES

Sample #	Distance from 0(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm[1])	Cl⁻ conc. mg/L
Transect I							
MI-1	-1.5	edge of pond	sandysilt	21	7.30	515	94.0
MI-3	5	*Juncus acutis*	sandy silt	6	6.81	312	48.0
MI-10	65	*Salicornia*	coarse sand	2	7.00	255	28.0
MI-10.2	85	*Salicornia*	clay	22	6.71	-	1080.0
MI-11	100	*Distichlis*	clayey sand	14	6.49	2675	714.0
MI-11.5	145	*Distichlis* & *Salicornia*	clayey sand	14	6.95	1260	270.0
MI-12	160	*Distichlis* & *Haplopappus*	sand	1	6.59	127	18.0
Transect II							
MII-17	380	*Jaumea*, *Distichlis*	silty clay	27	7.20	1540	252.0
MII-21	480	*Typha*	peaty clay	55	7.15	1350	186.0
Sample Area A							
MA-1		salt flat	silty clay	15	6.56	16400	4420.0
MA-2		*Salicornia*	silty clay	22	6.45	11000	1420.0
MA-3		*Jaumea*, *Frankenia*	silty clay	29	6.90	6600	132.0
MA-4		*Salix hindsiana*	clayey silt	36	6.81	5045	210.0
Sample Area B							
MB-1		*Juncus acutis*		23	7.49	935	130.0
MB-2		fringe of *Juncus*		33	6.88	2050	342.0
MB-3		*Distichlis*		28	7.00	1295	172.0
MB-4		*Anemopsis*		29	7.30	835	108.0
MB-5		*Typha domingensis*		35	7.14	755	82.0

1 @ 25°C

TABLE 7

LAS FLORES SOIL ANALYSES

Transect I

Sample #	Distance from 0(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm)[1]	Cl^- conc. (mg/L)
FI-1	0	grassland	sandy clay	1.5	6.53	210	28.0
FI-2	40	grassland	sandy clay	3.5	6.79	259	20.0
FI-3a	60	grassland	sandy clay, top 4 ins.	16.0	7.13	375	54.0
FI-3b	60	grassland	silty sand, bottom 4 ins.	14.0	9.18	385	24.0
FI-4a	80	*Baccharis*	top 4 ins.	20.0	7.12	560	68.0
FI-4b	80	"	bottom 18"	16.0	7.59	145	12.0
FI-5	100	*Typha latifolia*	clayey	29.0	7.38	900	26.0
FI-10	180	*Polypogon* & *Epilobium*	silty clay	33.0	7.49	382	22.0
FI-11	200	*Polypogon* & *Epilobium*	silty clay	30.0	7.30	450	20.0
FI-12	225	*Brassica* litter	silty clay	29.0	7.30	413	20.0
FI-13	285	*Haplopappus*	silty clay	24.0	7.10	1730	440.0

Transect II

Sample #	Distance from 0(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm)[1]	Cl^- conc. (mg/L)
FII-1	0	*Salicornia*	gray silty clay	27.0	7.15	7200	1080.0
FII-4	63	*Salicornia*	silty clay	23.0	7.00	6400	1400.0
FII-7	125	edge of *Scirpus*	gray sticky clay	30.0	7.50	1065	74.0
FII-7'	"	"	surface water	-	-	-	220.0
FII-10.5	190	*Scirpus olneyi*	gray peaty clay	47.0	7.40	1375	110.0
FII-10.5'	"	"	surface water	-	-	-	230.0

1 @ 25°C

TABLE 8

SAN MATEO SOIL ANALYSES

Transect I

Sample #	Distance from O(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm)[1]	Cl^- conc. (mg/L)
SMI-2	20	*Baccharis*	dry sandy clay	3.5	6.85	262	27.0
SMI-4	60	*Baccharis*	dry sandy clay	3.5	6.75	285	20.0
SMI-5	70	*Jaumea*	silty clay	25.0	6.35	1015	104.0
SMI-7	90	*Jaumea*	silty clay	28.0	6.72	1125	200.0
SMI-8	100	fringe of *Scirpus californicus*	gray sticky clay	30.0	6.55	960	192.0
SMI-9	110	*Scirpus calif.*	gray sticky clay	38.0	6.94	1410	332.0
SMI-12	140	*Scirpus* fringe	silty clay	28.0	6.91	1110	210.0
SMI-14	160	*Jaumea*	silty clay	28.0	6.89	1175	162.0
SMI-16	190	*Anemopsis*	silty clay	30.0	6.91	950	170.0

Transect II

Sample #	Distance from O(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm)[1]	Cl^- conc. (mg/L)
SMII-1	0	*Polygonum* & *Typha*	dark brown peaty clay	38.0	7.20	1925	240.0
SMII-8	140	*Scirpus olneyi*	dark brown peaty clay	65.0	7.85	2050	100.0
SMII-8'	"	"	surface water	-	-	-	240.0

Sample Area E

Sample #	Distance from O(ft)	Vegetation Type	Soil Type	% Water Content	pH	Conductivity (micromhos/cm)[1]	Cl^- conc. (mg/L)
SME-1		*Salix*	gray sticky clay	43.0	7.05	910	44.0
SME-2		*Scirpus calif.*	sticky clay	50.0	6.52	600	36.0

1 @ 25° C

EXHIBITS

EXHIBIT A

CHECK-LIST OF WETLAND FLORA AT SANTA MARGARITA

Symbols: r - rare, o - occasional, c - common, lc - common locally, f - frequent, a - abundant, la - locally abundant, va - very abundant

NON-FLOWERING PLANTS

Ulvaceae

Enteromorpha cf. prolifera
c in slow-moving water of tidal channels and in ponds within the tidal zone

MONOCOTS

Cyperaceae

Scirpus acutus Muhl ex Bigel. TULE, GREAT BULRUSH
apparently r in cattail-bulrush community
Note: this species is difficult to distinguish from S. californicus without examining the floral parts; the relative abundance of the former species may not have been accurately assessed

Scirpus californicus(C.A.Mey.)Steud. CALIFORNIA BULRUSH
o - la in cattail - bulrush community

Scirpus robustus Pursh. ALKALI BULRUSH
o in Jaumea-rush community at Area A and on the north shore of Sweetwater, o around temporary pools toward the upper edge of the tidal zone

Gramineae

Arundo Donax L. GIANT REED
la on upland fringe of wetlands north of Area B

Bromus mollis L. SOFT CHESS
c in grassy areas of salt-flat south of the lagoon

Bromus rubens L. RED BROME
c in grassy areas of salt-flat south of the lagoon, o in disturbed sandy areas of the saltmarsh grass association

Distichlis spicata (L.) Greene ssp. stricta(Torr.)Beetle SALTMARSH GRASS
a in upper littoral zone towards the dunes, c in upper part of pickle-weed community

Hordeum murinum L. WILD BARLEY
c in grassy areas of salt-flat south of the lagoon

Parafolis incurva (L.)C.E. Hubb. SICKLE GRASS
c in grassy areas of salt-flat south of the lagoon, often associated with small dry salt-pans

Polypogon monspeliensis(L.)Desf. RABBIT-FOOT GRASS
o in disturbed areas of upper littoral grassland, on the dunes and around small salt-pans in the pickleweed community

Juncaceae

Juncus bufonius L. COMMON TOAD RUSH
c around small pans in grassland south of the lagoon

Juncus acutis L. var.sphaerocarpus Engelm. SPINY RUSH
lc - la in Jaumea-rush community, r in upper levels of pickleweed community

EXHIBIT A continued

Lemnaceae	Lemna cf. minor L. SMALLER DUCKWEED o in submersed soil areas of cattail-bulrush community at Transect II
Ruppiaceae	Ruppia maritima L. DITCH GRASS lc in saline ponds on the southern salt-flat and in the large pond west of the southern dune barrier
Typhaceae	Typha domingensis Pers. CATTAIL f in cattail-bulrush community, a at Area B
	Typha latifolia L. COMMON / BROAD-LEAVED CATTAIL a in cattail-bulrush community Note: Floral structures are necessary for the accurate identification of these two species; since flowering only began during the last week of the field-work, it was not possible to confirm the assessment of the relative proportions of these species

DICOTS

Aizoaceae	Mesembryanthemum crystallinum L. ICE PLANT c in grassland of southern salt-flat, r - o on dunes
	Mesembryanthemum chilense Mol. SEA FIG o in disturbed areas of saltmarsh grass association and on the dunes
	Mesembryanthemum edule L. HOTTENTOT FIG r in disturbed areas of saltmarsh grass association towards the northern dune barrier
	Mesembryanthemum nodiflorum L. LITTLE ICE PLANT a in open areas of grassland of southern salt-flat
Boraginaceae	Amsinckia intermedia F & M YELLOW FIDDLENECK c in grassland of southern salt-flat
	Heliotropium curassavicum L. var. oculatum(Heller)Jtn. CHINESE PUSLEY lc in Jaumea-rush community, o on inland fringe of dunes
Capparidaceae	Isomeris arborea Nutt. BLADDER POD r on upland fringe of disturbed Jaumea-rush community on the north-west side of Sweetwater, a in maritime bluff community
Caprifoliaceae	Sambucus coerulea Raf. BLUE ELDERBERRY r in upland fringe of willow swamp
Chenopodiaceae	Atriplex californica Moq. CALIFORNIA SALTWEED o in saltmarsh grass association of Area B
	Atriplex lentiformis(Torr.)Wats. ssp. Breweri(Wats.)Hall & Clem. LENSCALE lc in disturbed areas on upland margin of saltmarsh near Freeway bridge
	Atriplex patula L. ssp. hastata Hall & Clem. SPEARSCALE o - lc in pickleweed community, la on fringe of cattail-bulrush community

Exhibit A continued

Chenopodiaceae continued

Atriplex watsonii Nels. WATSON SALTBUSH
o in saltmarsh grass association toward the dunes

Chenopodium macrospermum Hook. f. var. farinosum(Wats.)J.T.Howell NETTLE-LEAVED GOOSEFOOT
r in open disturbed area of pickleweed at Transect II

Chenopodium californicum Wats. CALIFORNIA PIGWEED
lc in disturbed fresh-water seepage area west of Sweetwater

Salicornia subterminalis Parish GLASSWORT
lc in upper littoral zone fringing the saltpans and along the roadtrack on the north shore near the Freeway Bridge

Salicornia virginica L. PICKLEWEED
va in lower and mid-littoral zone throughout saltmarsh

Suaeda californica Wats. CALIFORNIA SEABLITE
r, only in disturbed upper littoral area on the south shore of the lagoon near the Freeway Bridge

Compositae

Amblyopappus pusillus H & A COAST WEED
c in open areas of grassland in southern salt-flat area

Ambrosia psilostachya D.C. var. californica(Rydb.) Blake WESTERN RAGWEED
f in Jaumea-rush community at Area B, on the inland edge of the dunes andin disturbed areas on the upland edge of the wetlands

Baccharis pilularis D.C. ssp. consanguinea(DC)Kuntze COYOTE-BRUSH
o in brush community on the north-east side of the wetlands

Baccharis viminea D.C. MULE-FAT
o in upland fringe of willow thickets

Composite A - tall annual herb similar in vegetative features to Aster exilis but impossible to identify accurately without flowers
lc in fringe of cattail-bulrush community east of Transect II

Cotula coronopifolia L. BRASS BUTTONS
lc around small pans in grassland of southern saltflats and at the upper fringe of the pickleweed community, r on inland fringe of dunes

Haplopappus venetus(H.B.K.)Blake ssp. vernonioides(Nutt.)Munz GOLDENBUSH
a in brush community on north-east side of wetlands, f on upland edge of saltmarsh grass association along the dunes

Jaumea carnosa(Less.)Gray JAUMEA
va throughout Jaumea-rush community, r - o in pickleweed association

Lasthenia glabrata Lindl. SALTMARSH DAISY
vr in open areas of grassland in southern salt-flats

Matricaria matricarioides(Less.)Porter PINEAPPLE-WEED
o in disturbed seepage area north of Sweetwater

Exhibit A continued

Compositae cont. Picris echioides L. OX-TONGUE
o in disturbed Jaumea-rush community on north-west side of Sweetwater

Pluchea purpurascens (Sw.) D.C. SALTMARSH FLEABANE
c throughout fringe of cattail-bulrush community, o in Jaumea-rush community

Sonchus asper L. PRICKLY SOWTHISTLE
o in disturbed areas of saltmarsh

Sonchus oleraceus L. COMMON SOWTHISTLE
c in grassland areas of salt-flat south of the lagoon , o in disturbed upland areas

Xanthium strumarium L. var. glabratum(D.C.)Cronq. COCKLEBUR
o in Jaumea-rush community at Area A

Convolvulaceae Convolvulus sepium L. var. repens(L.)Gray BINDWEED
la on fringe of cattail-bulrush community at Transect II

Cressa truxillensis H.B.K. var. vallicola(Heller)Munz ALKALI WEED
o in grassy areas of southern saltflat, r in saltmarsh grass association

Cuscuta salina Engelm. var. squamigera(Engelm.) Yuncker SALTMARSH DODDER
o in upper littoral zone of marsh south of the lagoon,la in Jaumea-rush community at Transect II

Cruciferae Brassica nigra(L.)Koch BLACK MUSTARD
lc in disturbed Jaumea-rush community on north and west shores of Sweetwater

Hutchinsia procumbens (L.) Desv. NANNIE'S PURSE
o in grassland of southern saltflats

Lepidium lasiocarpum Nutt. SAND PEPPERGRASS
lc in saltmarsh grass association towards the dunes, o on inland fringe of dunes

Frankeniaceae Frankenia grandifolia Cham. & Schlecht ALKALI HEATH
la in pickleweed community, o throughout tidal zone

Hydrophyllaceae Phacelia distans Benth. WILD HELIOTROPE
lc in grassland of southern salt-flat

Leguminosae Astragalus tener Gray var. titi (Eastw.)Barneby ALKALI LOCOWEED
lc in grassland of southern salt-flat
Note: this is one of the rarest native species in San Diego county and should be protected during the proposed excavation of channels in the salt-pan area

Medicago hispida Gaertn. BURCLOVER
c in grassland of southern salt-flat area

Melilotus indicus(L.)All. SWEETCLOVER
lc throughout disturbed areas of wetlands

Exhibit A continued

Plumbaginaceae — Limonium californicum(Boiss.)Heller var. mexicanum(Blake)Munz SEA LAVENDER
o in saltmarsh grass association south of the lagoon only

Polygonaceae — Rumex crispus L. CURLY DOCK
lc in disturbed areas of fresh-water communities

Rumex salicifolius Weinm. WILLOW-LEAVED DOCK
o in fringe of cattail-bulrush community

Primulaceae — Anagallis arvensis L. PIMPERNEL
o - lc in sandy disturbed areas of saltmarsh grass association and on dunes

Salicaceae — Salix lasiolepis Benth. ARROYO WILLOW
a in willow swamp, lc in scattered on upland fringe of wetlands

Salix hindsiana Benth. SAND-BAR WILLOW, GRAY-BARK WILLOW
la on upland fringe of wetlands at Area A

Saururaceae — Anemopsis californica Hook. YERBA MANSA
la in Jaumea-rush community at Area B and east of Area A

Solanaceae — Nicotiana glauca Graham TREE TOBACCO
r weed in disturbed area on north-west side of Sweetwater

Solanum douglasii Dunal. DOUGLAS NIGHTSHADE
r in fringe of cattail-bulrush community at Area B, o in disturbed upland area east of Sweetwater

Umbelliferae — Apium graveolens L. CELERY
o in Jaumea-rush community and disturbed seepage areas along upland border

Conium maculatum L. POISON HEMLOCK
lc in grassland of southern salt-flat

Foeniculum vulgare(L.)Gaertn. SWEET FENNEL
lc in disturbed upland margin north-west of Sweetwater and east of Area A

EXHIBIT B

CHECK-LIST OF WETLAND FLORA AT LAS FLORES

Symbols: r - rare, o - occasional, c - common, lc - locally common, f - frequent, a - abundant, la - locally abundant, va - very abundant

NON-FLOWERING PLANTS

Characeae

Chara sp. MUSK-GRASS
a in open pools of pioneer floodland community and in small pond at the south drainage exit, o - lc in cattail-bulrush community

Cladophoraceae

Cladophora sp.
o - a in pools of pioneer floodland community, o in cattail-bulrush community

Ulvaceae

Enteromorpha sp.
c in pools in salt pan and pickleweed community

MONOCOTS

Cyperaceae

Eleocharis montevidensis Kunth SPIKE RUSH
lc in pioneer floodland community west of Transect II
var. parishii (Britton)V.Grant PARISH SPIKE RUSH
lc in fringe of cattail-bulrush community

Eleocharis palustris(L.)R & S COMMON SPIKE RUSH
= E. macrostachya Britt.
lc in pickleweed and cattail-bulrush communities of Transect II

Scirpus californicus (C.A.Mey.)Steud. CALIFORNIA BULRUSH
la in cattail-bulrush community in western part of drainage, becoming rare in the eastern areas

Scirpus olneyi Gray OLNEY BULRUSH
va throughout cattail-bulrush community

Scirpus robustus Pursh. ALKALI BULRUSH
o in disturbed cattail-bulrush community at Area A

Gramineae

Bromus mollis L. SOFT CHESS
o in pioneer floodland community, a in disturbed grassland

Bromus rubens L. RED BROME
o in salt pan areas, a in disturbed grassland

Distichlis spicata (L.)Greene ssp. stricta SALT-MARSH GRASS
o on emersed soils of pickleweed community

Hordeum murinum L. WILD BARLEY
o in pioneer floodland community on emersed soils, a in disturbed grassl

Lolium perenne L. ENGLISH RYE GRASS
r in fringe of cattail-bulrush community

Exhibit B continued

Gramineae cont. Parafolis incurva(L.)C.E.Hubb. SICKLE GRASS
o in pioneer floodland community towards the ocean

Polypogon monspeliensis (L.)Desf. RABBIT-FOOT GRASS
c in pickleweed and salt pan communities, la in pioneer floodland community and on the fringe of the cattail-bulrush community

Juncaceae Juncus bufonius L. COMMON TOAD RUSH
lc in pioneer floodland community

Lemnaceae Lemna cf. valdiviana Phil. DUCK WEED
o throughout most of cattail-bulrush community

Sparganiaceae Sparganium eurycarpum Engelm.in Gray BROAD-FRUITED BUR REED
r in cattail-bulrush community near southern drainage exit, confined to edge of open water

Typhaceae Typha domingensis Pers.
common in cattail-bulrush community towards ocean, apparently r elsehere

Typha latifolia L. COMMON CATTAIL
a in cattail - bulrush community in eastern part of drainage, lc in western portion
Note: floral structures are necessary for the accurate identification of these two species; since flowering only began during the last week of study, the relative proportions of these species may not have been accurately estimated

Zannichelliaceae Zannichellia palustris L. GRASS WRACK, HORNED PONDWEED
r in ponds of pioneer floodland community in southern part of drainage area

DICOTS

Aizoaceae Mesembryanthemum nodiflorum L. LITTLE ICE PLANT
lc in salt pan areas of pickleweed community

Boraginaceae Heliotropium curassavicum L. var. oculatum (Heller) Jtn. CHINESE PUSLEY
r on edges of ponds in pioneer floodland community

Caprifoliaceae Sambucus coerulea Raf. BLUE ELDERBERRY
o in upland margin of willow thickets, o in brush and old-field community

Caryophyllaceae Spergularia marina (L.) Griseb. SALTMARSH SAND SPURREY
a in salt pan areas, c in pickleweed community, o on emersed soils of floodland pioneer community towards the ocean

Chenopodiaceae Atriplex lentiformis (Torr.)Wats. ssp. breweri(Wats) Hall & Clem. SHADSCALE, LENSCALE
r on emersed soils of pioneer floodland community south of drainage; lc on inland edge of dunes

Exhibit B continued

Chenopodiaceae cont. Atriplex patula L. ssp. hastata Hall & Clem. SPEARSCALE
o in pickleweed community, c in fringe of cattail-bulrush commnuity, also o in undercover within the community

Atriplex semibaccata Brown AUSTRALIAN SALTWEED
o in pickleweed community and in salt pans, c in dry open upland areas

Chenopodium macrospermum Hook. f. var. farinosum(Wats.)J.T. Howell NETTLE-LEAVED GOOSEFOOT
r in flooded pioneer community

Salicornia virginica L. PICKLEWEED
la in pickleweed community and saltpan areas

Suaeda depressa(Pursh.) Wats. SEABLITE
lc on fringe of pickleweed community south of drainage

Compositae Baccharis pilularis D.C. ssp. consanguinea(DC)Kuntze COYOTE-BRUSH
r in fringe of cattail-bulrush community, lc in brush and old-field community

Baccharis viminea D.C. MULE-FAT
lc in fringe of willow thickets

Composite A - tall annual herb similar in vegetative features to Aster exilis but impossible to identify accurately without flowers which were not present
lc in fringe of cattail-bulrush community towards east, r in pickleweed community of Transect II

Cotula coronopifolia L. BRASS BUTTONS
a throughout open wetland area, o in undercover of cattail community

Haplopappus venetus(H.B.K.)Blake ssp. vernonioides(Nutt.)Munz GOLDENBUSH
lc in flooded pioneer community, often dead, c - a in brush on upland fringe

Jaumea carnosa(Less.)Gray JAUMEA
la in restricted area of cattail-bulrush fringe on south-west side of drainage

Picris echioides L. OX-TONGUE
o-c in fringe of cattail community, r within community; la in oldfield community

Pluchea purpurascens(Sw.) D.C. SALTMARSH FLEABANE
c throughout cattail-bulrush community, o in floodland pioneer community

Sonchus oleraceus L. COMMON SOWTHISTLE
r in floodland pioneer community, c in disturbed grassland and oldfield community

Convolvulaceae Cressa truxillensis H.BK. var. vallicola (Heller) Munz ALKALI WEED
c in salt-pan area of pickleweed community, o in pioneer floodland community towards ocean

Exhibit B continued

Cruciferae — *Brassica campestris* L. FIELD MUSTARD
lc in floodland pioneer community away from the ocean, often dead; va throughout old-field community and disturbed upland areas

Nasturtium officinale R. Br. WATER-CRESS
la in fringe of cattail-bulrush community away from the ocean

Euphorbiaceae — *Ricinus communis* L. CASTOR BEAN
o in upland margin of cattail-bulrush fringe of inland drainage area

Frankeniaceae — *Frankenia grandifolia* Cham. & Schlecht ALKALI HEATH
r - la in pickleweed community

Leguminosae — *Melilotus indicus* (L.)All. SWEET CLOVER
r in pickleweed community, c throughout open areas of all wetland communities, a in upland communities

Lythraceae — *Lythrum hyssopifolia* L. LOOSESTRIFE, GRASSPOLY
r in fringe of cattail-bulrush community

Malvaceae — *Sida hederacea* (Dougl.)Torr. ALKALI MALLOW
r in cattail-bulrush community of Transect II, o in adjacent sand-dune community

Onagraceae — *Epilobium adenocaulon* Hausskn. var. *parishii* (Trel.)Munz CALIFORNIA COTTONWEED
la in fringe of cattail-bulrush community away from the ocean, o in inland floodland pioneer community

Polygonaceae — *Rumex crispus* L. CURLY DOCK
la in fringe of cattail-bulrush community, o - c in all other communities

Plantaginaceae — *Plantago* cf. *hirtella* H.B.K. PLANTAIN
r in fringe of cattail community and in floodland pioneer community of Transect II

Salicaceae — *Salix lasiolepis* Benth. ARROYO WILLOW
la in willow swamp on inland area of drainage, r in cattail-bulrush community

Saururaceae — *Anemopsis californica* Hook. YERBA MANSA
la in restricted area on fringe of cattail-bulrush community on the south-west side of the drainage area

Solanaceae — *Solanum douglasii* Dunal. DOUGLAS NIGHTSHADE
r in cattail-bulrush fringe of Transect I, o in upland communities

Scrophulariaceae — *Mimulus guttatus* Fischer ex D.C. COMMON MONKEY FLOWER
r in fringe of catail-bulrush community east of Transect I

Umbelliferae — *Apium graveolens* L. CELERY
c throuhout fringe of cattail-bulrush community, o in floodland pioneer community

Conium maculatum L. POISON HEMLOCK
o in fringe of cattail-bulrush community near the Freeway, o in upland communities

EXHIBIT C

CHECK-LIST OF WETLAND FLORA AT SAN MATEO

Symbols: r - rare, o - occasional, c - common, lc - locally common, f - frequent, a - abundant, la - locally abundant, va - very abundant

NON-FLOWERING PLANTS

Characeae

Chara sp. MUSK-GRASS
la in pools of sand-bar pioneer community

Ulvaceae

Enteromorpha sp.
la in pools of sand-bar pioneer community

MONOCOTS

Cyperaceae

Carex praegracilis W. Boott. CLUSTERED FIELD SEDGE
o - lc in Jaumea-rush community at Area A

Carex spissa Bailey SAN DIEGO SEDGE
r in disturbed Jaumea-rush community at Area C

Cyperus eragrostis Lam GREEN SEDGE
r in sand-bar pioneer community

Eleocharis montevidensis Kunth var. Parishii (Britton) V. Grant PARISH SPIKE RUSH
lc in Jaumea-rush communities

Eleocharis acicularis (L.) Roem. & Schultz SLENDER SPIKE RUSH
o in sand-bar pioneer community

Scirpus californicus (C.A. Mey.) Steud. CALIFORNIA BULRUSH
va throughout most of cattail-bulrush community, f on the fringe of and in clearings within the willow swamp.
Note: This species is not readily distinguishable from Scirpus acutus in the Southern Californian coastal region and small quantities of the latter species may have been present.

*

Scirpus cernuus Vahl. var. californicus (Torr.) Beetle LOW CLUB RUSH
la along roadtrack and in disturbed Jaumea-rush community at Area C

Scirpus microcarpus Presl. SMALL-FRUITED BULRUSH
o in fringe of willow swamp and in the sand-bar pioneer community

Gramineae

Distichlis spicata (L.) Greene ssp. stricta SALT-MARSH GRASS
a in Jaumea-rush community

Polypogon monspeliensis (L.) Desf. RABBIT-FOOT GRASS
o in disturbed areas and in the sand-bar pioneer community

* Scirpus olneyi Gray OLNEY BULRUSH
va in cattail-bulrush community east of RR, la in several areas west of RR

Exhibit C continued

Juncaceae	Juncus mexicanus Willd. MEXICAN RUSH c in Jaumea-rush community and in the coyote brush scrub fringing the dune barrier where it may become la
	Juncus xiphioides Meyer IRIS-LEAVED RUSH o in sand-bar pioneer community
Potamogetonaceae	Potamogeton pectinatus L. SEGO PONDWEED r in pools of pioneer sand-bar community
Sparganiaceae	Sparganium eurycarpum Engelm. in Gray BROAD-FRUITED BUR REED o - lc around areas of open water below the railroad trestles; usually associated with cat-tail - bulrush community
Typhaceae	Typha domingensis Pers. apparently r in cattail-bulrush community
	Typha latifolia L. COMMON CAT-TAIL apparently the dominant cat-tail species in the cattail-bulrush association, o - la throughout the submersed soil community Note: difficulty was experienced in separating these two species on vegetative characters alone; since flowering only began during the last week of field studies, it was not possible to accurately assess the relative proportions of these two species.
Zannichelliaceae	Zannichellia palustris L. GRASS WRACK, HORNED PONDWEED o in pools of pioneer sand-bar community

DICOTS

Aizoaceae	Mesembryanthemum chilense L. SEA FIG o on disturbed soil mounds in the Jaumea-rush community at Transect I
Anacardiaceae	Rhus diversiloba T and G POISON-OAK c in fringe of willow swamp, o in disturbed Jaumea-rush community
Boraginaceae	Heliotropium curassavicum L. var. oculatum(Heller)Jtn. CHINESE PUSLEY r in Jaumea-rush community of Transect I
Betulaceae	Alnus rhombifolia Nutt. WHITE ALDER r on fringe of cattail-bulrush community in Area B; o - lc in the riparian woodland
Caprifoliaceae	Sambucus coerulea Raf. BLUE ELDERBERRY o in fringe of willow swamp, c in riparian woodland

Exhibit C continued

Compositae — Baccharis pilularis D.C. ssp. consanguinea (D.C.)Kuntze COYOTE-BRUSH
la in brush community and in cleared upland areas within or on the fringe of the willow thickets and riparian woodland; r in margin of cattail-bulrush community at Transect I

Baccharis viminea D.C. MULE FAT
o - lc in brush fringe community

Composite A - tall annual herb similar in vegetative features to Aster exilis but impossible to identify accurately without flowers.
a in fringe of cattail-bulrush community and in disturbed areas throughout the region

Cotula coronopifolia L. BRASS BUTTONS
r in sand-bar pioneer community

Gnaphalium palustre Nutt. LOWLAND CUDWEED
r in sand-bar pioneer community

Helenium puberulum D.C. SNEEZEWEED
o in disturbed community at Area C

Iva axillaris Pursh. POVERTY WEED
r in disturbed roadside community at Area C

Jaumea carnosa (Less.)Gray JAUMEA
va in Jaumea-rush community throughout area

Picris echioides L. OX-TONGUE
la in disturbed Jaumea-rush community and along roadtrack at Area C

Pluchea purpurascens(Sw.)D.C. SALT-MARSH FLEABANE
o throughout wetland area, c - la in disturbed moist areas

Sonchus asper L. PRICKLY SOWTHISTLE
o in Jaumea-rush community

Convolvulaceae — Cuscuta salina(Engelm.) var. squamigera (Engelm.)Yuncker SALTMARSH DODDER
o - lc in Jaumea-rush community at Transect I area only

Cruciferae — Brassica nigra(L.)Koch BLACK MUSTARD
o on disturbed soil mounds in Jaumea-rush community at Transect I, a in disturbed areas of upland borders

Euphorbiaceae — Euphorbia lathyris L. CAPER SPURGE
r in Jaumea-rush community

Frankeniaceae — Frankenia grandifolia Cham. & Schlecht ALKALI HEATH
r in Jaumea-rush and brush communities at Transect I area

Labiatae — Stachys rigida Nutt.ex Benth. HEDGE NETTLE
r in fringe of willows near Area A

Exhibit C continued

Leguminosae	Amorpha fruticosa L. var. occidentalis (Abrams)Kearn. & Peebles FALSE INDIGO r in upland fringe of willows along RR, o in riparian woodland
	Trifolium variegatum Nutt. in T & G WHITE-TIP CLOVER o in sand-bar pioneer community
Lythraceae	Lythrum hyssopifolia L. LOOSESTRIFE, GRASSPOLY o - lc in disturbed Jaumea community at Area C
Onagraceae	Epilobium adenocaulon Hausskn. var. holosericeum (Trel.)Munz COTTONWEED r in disturbed community at Area C
	var. parishii(Trel.)Munz CALIFORNIA COTTONWEED c in disturbed Jaumea-rush community, o on fringe of cattail-bulrush community at Area B
Platanaceae	Platanus racemosa Nutt. CALIFORNIA SYCAMORE r in willow swamp at Area E, common in riparian woodland
Polygonaceae	Polygonum coccineum Muhl. ex Willd. PINK SMARTWEED c in cattail-bulrush community at Transect II, la in upland fringe along the railroad
	Polygonum punctatum Ell. PERENNIAL SMARTWEED o - locally common in fringe of cattail-bulrush community throughout area
	Rumex salicifolius Weinm. WILLOW-LEAVED DOCK o in cattail-bulrush community at Area B
Rosaceae	Rosa californica C & S WILD ROSE o in fringe of cattail-bulrush community at Transect I; c in upland fringe of willow thickets and in riparian woodland
Saururaceae	Anemopsis californica Hook. YERBA MANSA o - la in Jaumea-rush community and disturbed wetland areas throughout region
Salicaceae	Salix cf. lasiolepis ARROYO WILLOW va in willow swamp throughout area Note: this species is not readily distinguishable from S. lasiandra without refering to the catkins; both species may be present
	Salix laevigata Bebb. var. araquipa (Jeps.) Ball RED WILLOW r in willow swamp south of Area E
Solanaceae	Nicotiana bigelovii Wats. var. wallacei Gray INDIAN TOBACCO o in pioneer sand-bar community
Scrophulariaceae	Mimulus guttatus Fischer ex D.C. COMMON MONKEY FLOWER lc in pioneer community of sand-bar
	Mimulus pilosus (Benth.) Wats. FALSE MONKEY FLOWER o in pioneer sand-bar community

Scrophulariaceae	Veronica anagallis-aquatica L. SPEEDWELL lc in pioneer sand-bar community
Umbelliferae	Apium graveolens L. CELERY va in disturbed Jaumea community at Area C, o on margin of cattail-bulrush community and Jaumea-rush community throughout area
	Foeniculum vulgare (L.) Gaertn. SWEET FENNEL o in upland fringe of Jaumea-rush community, c in disturbed upland margins
Urticaceae	Urtica holosericea Nutt. NETTLE f in fringe of cattail-bulrush community and on disturbed upland margins